AMERICAN MACHINIST

JOURNAL FOR MACHINISTS, ENGINEERS, FOUNDERS, BOILER MAKERS, PATTERN MAKERS AND BLACKSMITHS.

VOL. 13, No. 27. WEEKLY. | NEW YORK, THURSDAY, JULY 3, 1890. | $3.00 per Annum. SINGLE COPIES 6 CENTS.

COPYRIGHT 1890, BY AMERICAN MACHINIST PUBLISHING COMPANY.

For Sale Everywhere by Newsdealers.

ENTERED AT POST OFFICE, NEW YORK, AS SECOND CLASS MATTER.

The Fishkill Corliss Engine.

On this and the succeeding page we illustrate the latest design of what is known as the "Fishkill" Corliss engine, made by the Fishkill Landing Machine Co., Fishkill-on-the-Hudson, N. Y. A general view of the engine is given, together with such details as are necessary to make plain the recent modifications and improvements made by the builders.

As will be seen, the general design is of the standard or original Corliss type, with a bed which is calculated to be amply strong for all strains which may be placed upon it, but to which is added the central support at the outer end of the guides to secure additional rigidity, this stand also serving as a support for the pin upon which the rock-arm works. The cylinder is supported upon four substantial legs, which have a large bearing surface upon the foundation, two of them being extended to form the bases upon which rest the dash-pots. In the larger sizes the exhaust passages are made separate from the body of the cylinder, and in all sizes pains are taken to reduce clearance to the lowest possible limit.

These engines are sufficiently well known to make it unnecessary for us to speak of the quality of the materials used in their construction or of the workmanship put upon them, and we pass on to a description of the new features illustrated by our detail cuts.

This company has until recently been using a releasing valve gear known as Cité's, of which the present gear is a modification. Figs. 1, 2 and 3 show the mechanism, Fig. 1 being an elevation from the side next the cylinder, Fig. 2 from the opposite or outside, and Fig. 3 is a plan, similar letters of reference indicating the same parts throughout.

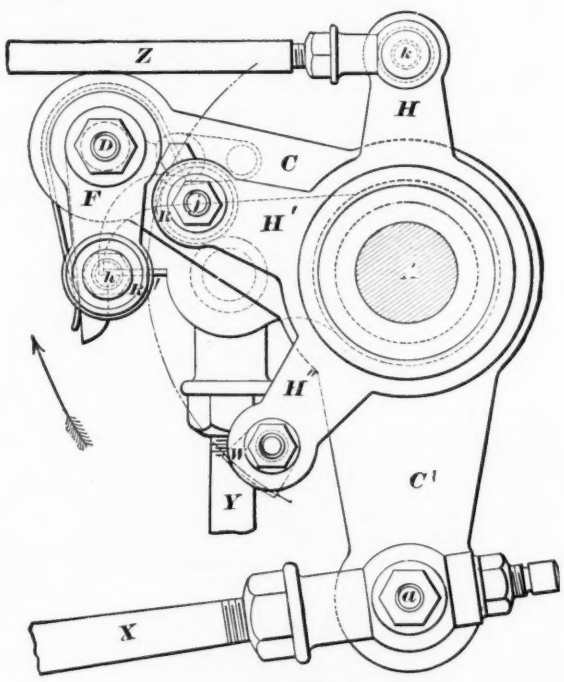


FIG. 1.

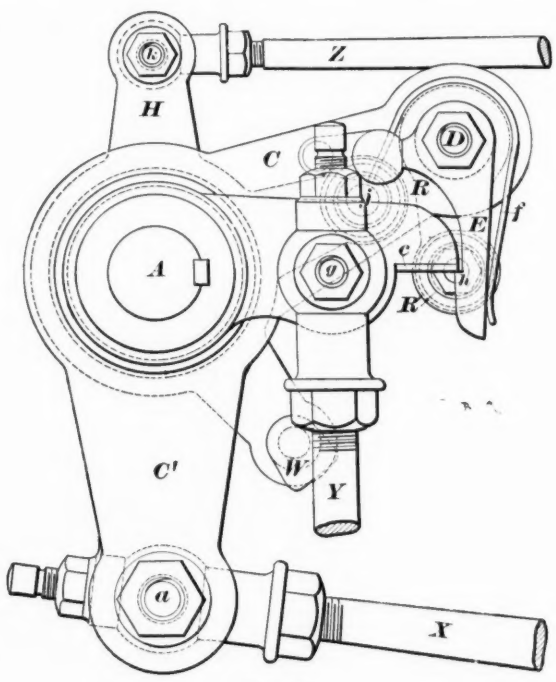


FIG. 2.

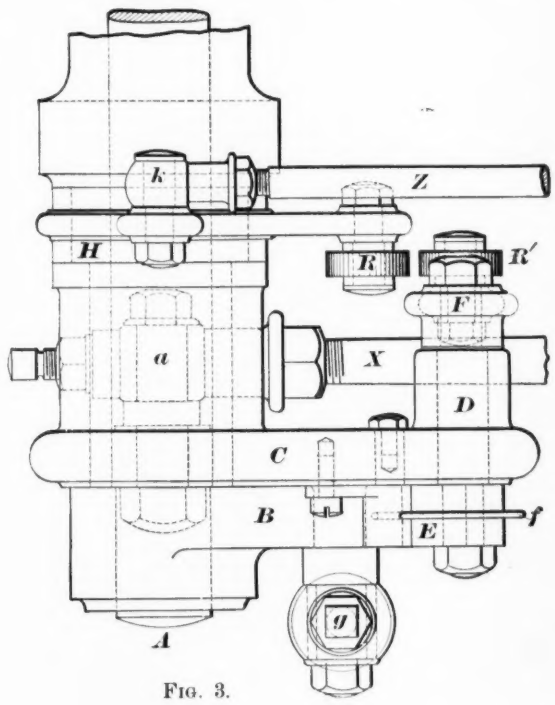
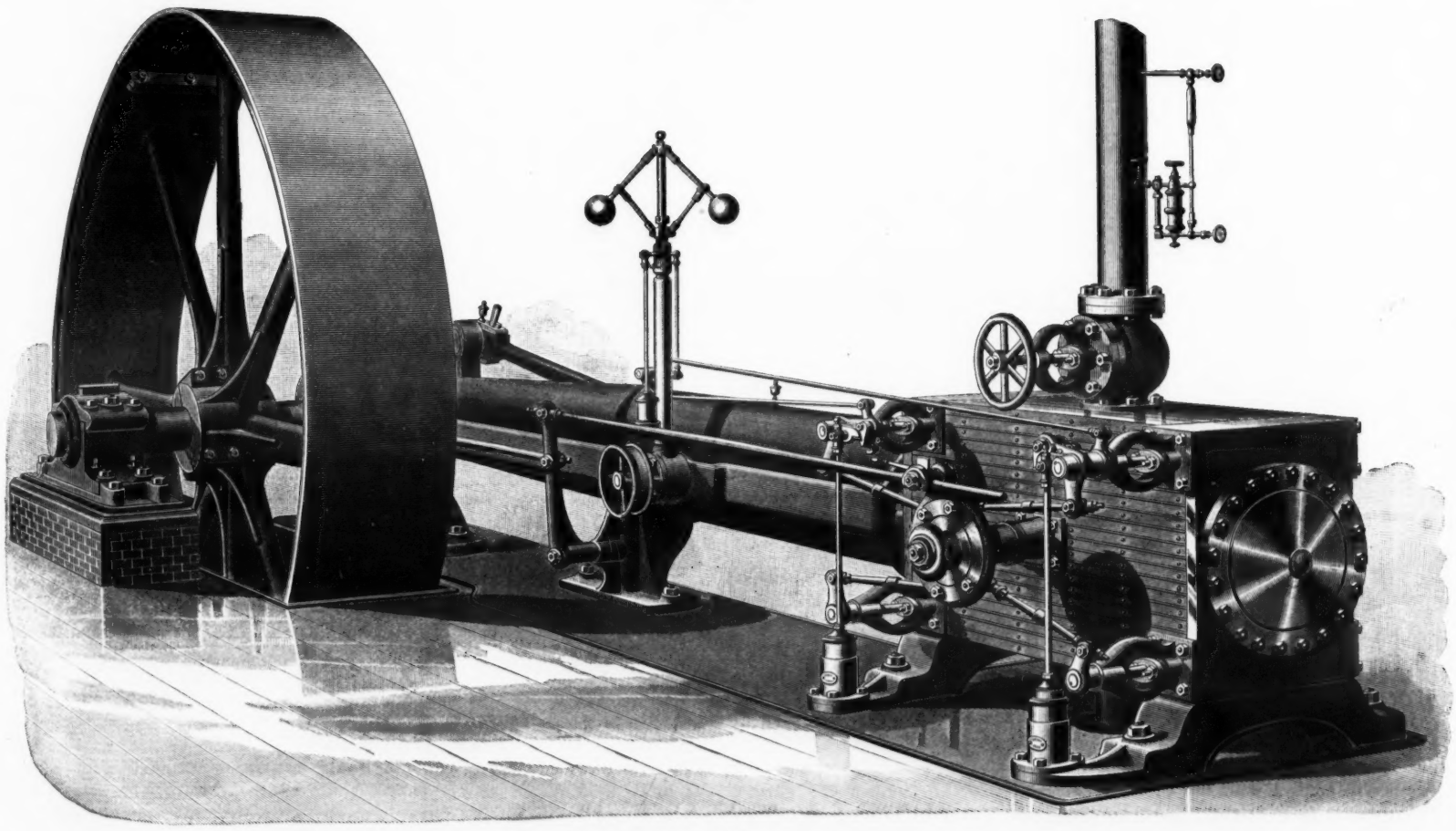


FIG. 3.



THE FISHKILL CORLISS ENGINE.

works loosely on a sleeve around the stem, the arm C carrying at its outer extremity a small rock-shaft D. This rock-shaft has attached to it at one end the hook E, and at the other the arm F, carrying the hardened steel roller R'. The spring f tends to keep the hook E in towards the stem, where it can engage with the catch-plate e, Fig. 1 showing them thus in engagement, and with the valve about the middle of its stroke. This engagement continues until the roller R' comes into contact with the roller R, when the hooks will commence to disengage. The actual release does not take place, however, until roller R' has passed upwards far enough to be very nearly in the radial line drawn from the center of stem through the center of roller R, thus at the moment of release exerting practically no force tending to disturb the governor, which, of course, determines the position of roller R. The governor connection Z is attached to an arm H, this arm being upon a ring which is turned by the action of the governor, and carries two other arms H' and H'', the latter carrying a cam W which serves the purpose of an automatic stop. The cam W is adjustable, and when the engine is at its lowest normal speed, and the hook E is at the point of engagement with the valve lever B, the roller R' comes nearly in contact with the cam. Now should the governor belt be broken, or if from any other cause the governor balls should fall below the point corresponding to the lowest normal speed, the bell crank H will move in the direction of the arrow; and the roller R' coming in contact with the cam, the hook is prevented from engaging, and, the valve remaining closed, the engine stops. By a simple device attached to the governor column the action of this stop may be suspended by the engineer at any time, as, of course, it is necessary that it should be in starting and until the engine has attained full speed.

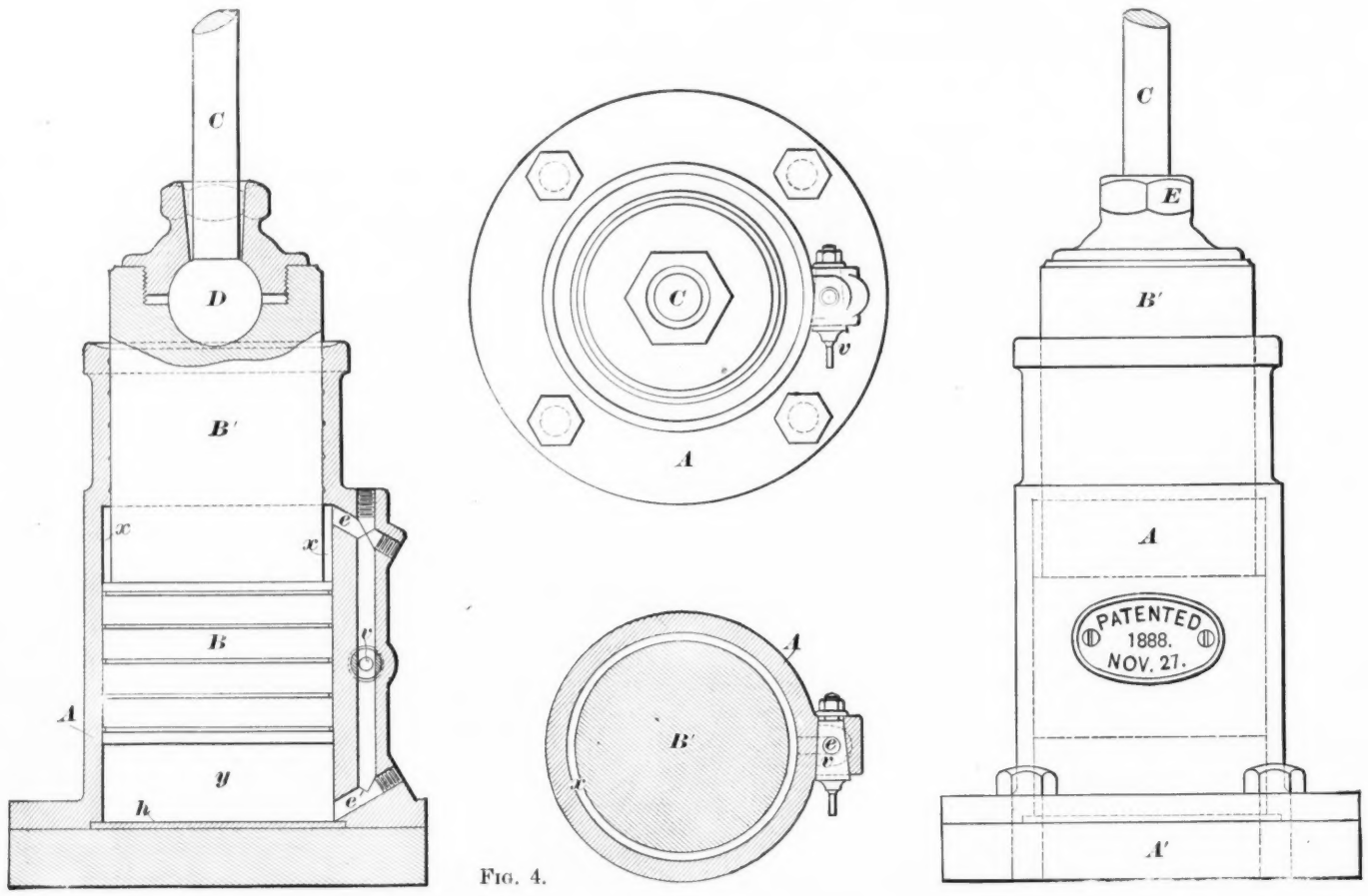


FIG. 4.

Fig. 4 gives a view of the improved dash-pot now used on these engines, and which is known as Cité's differential vacuum dash-pot. A is a cylindrical shell having two bores of different diameters, and fitted with a plunger B' B, which is a working fit in both bores. This plunger is connected with the valve lever by the rod C, having a ball joint as shown, The plunger is shown in the middle of its stroke, and, supposing it to be moving upwards, as it is when the valve is being opened, a chamber y is formed under it. This chamber is connected by the passage e e' with the annular chamber x, in which the contained air would be compressed by the upward movement of the plunger, were it not for the connecting passage e e'. But as the chamber y is so much greater in area than chamber x, the air is rarefied in both chambers, the degree of vacuum increasing with the rise of the plunger. When cut-off takes place the atmospheric pressure causes the plunger to descend rapidly, the partial vacuum formed in chamber x increases, while the rarefied air in chamber y, finding an obstruction in passing through the cock v, acts as a cushion, which arrests the motion of the parts, and does away with all pounding. As the air in this dash-pot is not drawn in from the outside atmosphere during the rise of the plunger, to be again forced out by its descent, but merely passes from one chamber to the other alternately, its action is entirely without noise. The cock v can be set to secure any desired action of the dash-pot, which, as will be seen, is simple and very quick in its action.

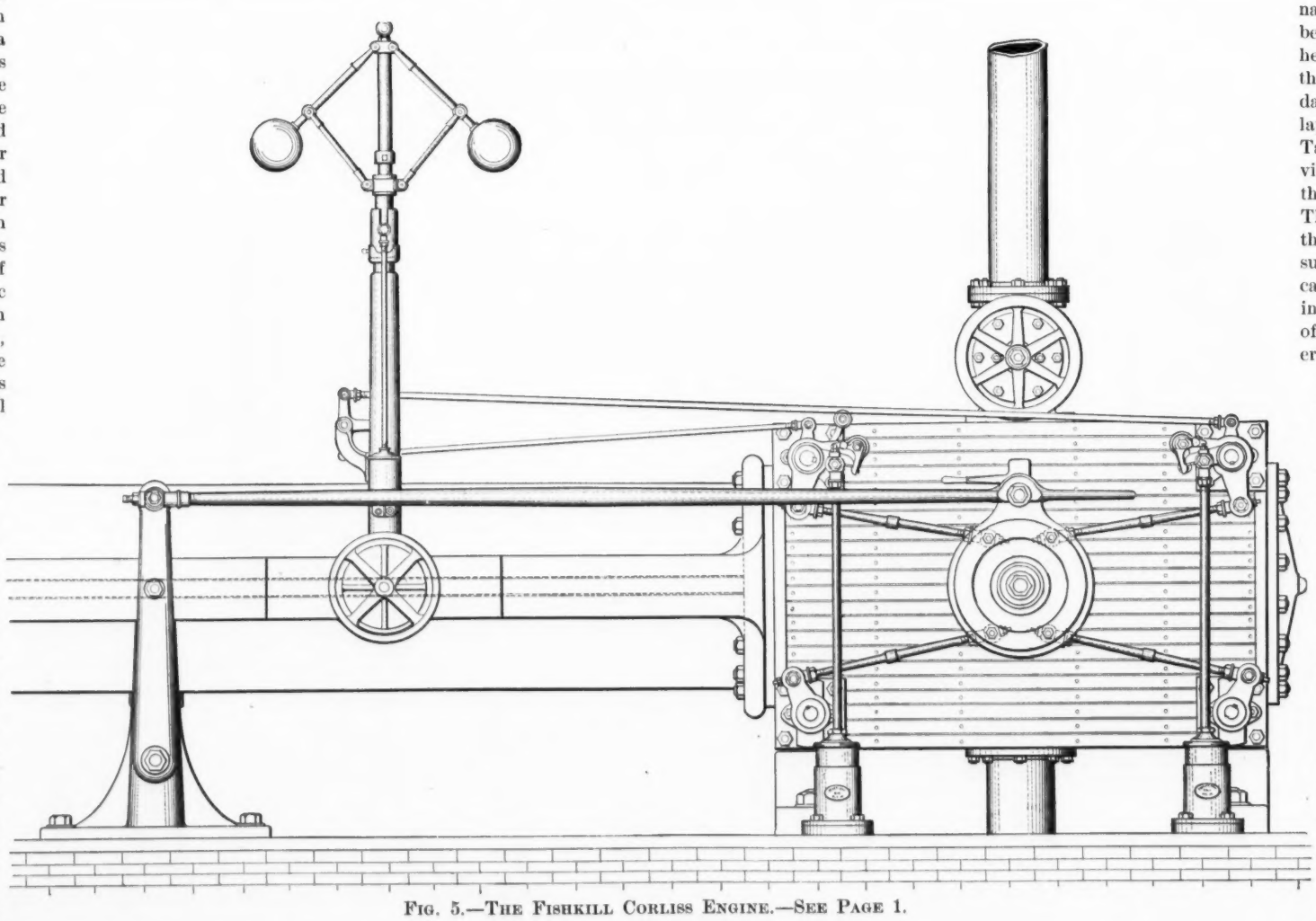


FIG. 5.—THE FISHKILL CORLISS ENGINE.—SEE PAGE 1.

Fig. 5 is made from a working drawing, and shows the proportion of the various parts of the valve-motion and governor. These improvements have now been in use a sufficient length of time to demonstrate their value, the governing action of engines so fitted having been found very satisfactory.

Thick and Thin Furnace Plates.

Mr. Alexander Taylor and Mr. W. Kelvington deserve the thanks of the profession for calling attention to the possibility of using plain furnace tubes at sea instead of corrugated tubes. We have already referred to their paper read before the Northeast Coast Institution of Engineers and Shipbuilders. The complete report of the discussion, which took place on the 10th of March, now lies before us, and is full of interest. There appears to be a vague popular belief that the rate at which a plate will transmit heat to water from a furnace varies as the thickness of the plate; and it is assumed that if a thick plate is used in a furnace it must become overheated, and will therefore be in danger of collapse. Messrs. Taylor and Kelvington combat this theory. They urge that the thickness of such plates as can be worked into the furnaces of a marine boiler has little or no influence on the rate of transmission, which really depends not on what goes on inside the plate, but on what takes place at its surfaces. It was shown long ago by Peclet that the absorbing and emitting powers of a plate are very much less than the conducting power of the metal. Thus, for example, if a peg of iron 1 in. in diameter and 6¼ in. long be driven tightly into a hole in a half-inch furnace plate, so that 3 in. of the peg are in the water and 3 in. in the fire, then the latter cannot be made over-hot while the surface of that part of the peg in the boiler is clean. The whole of the heat taken up by the 10 in. or 11 in. of peg surface in the fire must traverse the section half an inch long and one circular inch in area of the peg where it passes through the boiler plate, and this it will do quite easily. C. Wye Williams

patented his "heat pegs," the principle involved depending on the facts stated by Peclet, and they worked very well at first. They always ultimately failed, because it was impossible to keep them clean, and as soon as the surfaces inside the boiler became coated with scale, the outer ends in the furnace were burned away. Mr. Taylor and Mr. Kelvington advocate the use of furnace plates from ¾ in. to 1 in. thick, and the results obtained with such plates seem to have been very satisfactory.

The discussion showed that considerable differences of opinion exist as to the maximum practicable thickness of furnace plates. But no one was prepared to say that a ¾-in. plate, or even a 1-in. plate might not be used. Oddly enough, from the first argument about collapse from over-heating seemed to be abandoned, and no one hinted that a thick furnace would be less economical of fuel than a thin one. The most forcible objection raised was that unless some provision were made for the expansion and contraction of the furnace tube, leakage would be set up at the boiler front and the combustion chamber; and it was urged that whereas a corrugated flue would expand and contract by bending its corrugations slightly, a straight thick tube must break something. This argument, it will be seen, is really not against thick tubes, but against straight tubes, and has, in our opinion, very little weight. There ought to be no difficulty, seeing what the hydraulic flanging machine will do, in introducing a certain amount of flexibility into boiler ends, boiler shells, and combustion chambers. The moment the necessity for this flexibility is recognized, means will be adopted for endowing boilers with it. On one point most of the speakers seemed to be united, namely, that it was very much easier to keep a plain furnace clean than a corrugated furnace. These last are notorious scale collectors. Mr. Dykes, in the course of the discussion, put, as we think, the various aspects of the question so plainly that we make no apology for reproducing the words here. He said, "Much mischief was done to plain furnaces with triple expansion engines, owing to engineers raising steam too rapidly, often causing considerable leakage. He had plain furnaces about seven years old working at 150 lbs. pressure, and never had the slightest trouble with them. Lately, however, with plain furnaces at 160 lbs. pressure, he had had a good deal of trouble—the principal cause of this being through the engineer raising steam too rapidly, and omitting to use the blow-off cock when raising steam. He thought the great fault of plain furnaces as now fitted to high-pressure boilers is the abruptness of the flanging. He found very little trouble with scale adhering to the plain furnaces, and as far as pitting and scale were concerned, he would certainly recommend plain furnaces. He would like to see furnaces tried 1 in. thick, for he thought they would be less liable to collapse than corrugated furnaces, as these accumulated and kept the scale, thus preventing the water from gaining access to the plate. He had corrugated furnaces four and a half years old, and had no end of trouble with scale adhering to them. The inch plate, he thought, would not collapse, and he would much like to hear of the experiment being tried."

It is a somewhat remarkable fact that most of the speakers overlooked a very powerful argument in favor of the plain thick flue. It was taken for granted by its opponents that such a flue must become overheated, because the difference in temperature between the furnace side and the water side of the plate would be very considerable; but this difference must in any case depend in large measure on the heat of the furnace. Now the temperature in a locomotive fire-box is very much higher than it is in the furnace of a marine boiler, and if it is possible to use a ½-in. plate with this extreme temperature in the one case, why should it not be possible to use a ¾-in. plate in the other case with the lower furnace heat? If there is an argument to be urged to the contrary, we are not acquainted with it. As the discussion progressed the speakers appeared to become more and more in favor of the thick plain furnace, and various suggestions were made to show how objections to it could be got over. One speaker, for example, found that by merely shortening his grates he succeeded in stopping persistent leakage at the junction of the tube plate and the furnace. Mr. F. C. Marshall, the president, cited a case which came within his own experience. He said he was quite certain more boilers were ruined by over-staying than by under-staying. "He was extremely sorry to have to say that their friends of Lloyd's, the Board of Trade, and the Admiralty were 'all tarred with the same brush.' They saw the difficulty in expansion; it was essential that the boilers themselves should have room, as the boiler makers had it, 'to breathe.' They had a certain distance from the furnace to the lowest row of tubes, and with a strong joint at this point there was very little elasticity or breathing space. In the matter of staying it should be borne in mind that the boiler itself could never be higher in temperature than that of the water, and must not be expected to expand as much as the furnace, which had got 100 deg. more heat than the water. Now, in a certain boiler, double-ended and with six furnaces, they had great trouble with the joints immediately above the center furnace; the joints were sprung by the expansion, and leaked. They took out the long stays running from end to end and fitted instead two dog stays, and they had no further trouble, showing that the difference of temperature was entirely overlooked by Lloyd's and the Board of Trade, who insisted upon having these through stays. He could only hope that some means would be taken to induce their friends at Lloyd's, and every one of them as draftsmen and engineers, to be very careful in their designing, and allow their plates a little more 'breathing space' than they generally had. Their boilers would then be more durable and give less trouble with leaky joints and leaky tubes." With every syllable of this we cordially agree. We have continually insisted on the necessity of providing flexibility in boilers, instead of contending with the stresses to which they are submitted by brute force.

On the whole, it may be said that the discussion was in favor of adopting a method of boiler construction somewhat different from that now in vogue. The new boilers would have plain furnaces about ¾ in. thick, instead of corrugated furnaces ½ in. thick, and special arrangements would have to be adopted to promote flexibility, most probably at the boiler front. No evidence was brought forward to prove that thick furnaces were either dangerous or uneconomical. One speaker said that the great objection to them was that if they came down they could not be got back. This is rather a hard saying. Furthermore, the chances in favor of a plain furnace keeping up are greater than those on the side of the corrugated furnace. Most of the mischief that takes place in this way is, we think, due to the continued use of the salinometer and the auxiliary feed. If only engineers could be got to believe that so long as they keep salt water out of their boilers it matters nothing what the density may be, there would be less work for furnace lifters. The last has not, we think, been heard of the thick plain flue. Mr. Taylor and Mr. Kelvington have no reason to be dissatisfied with the reception their paper received.—*London Engineer.*

Professor Sweet on Roads.

Professor John E. Sweet has written a series of letters to a Syracuse paper on the comprehensive subject of road-making.

Syracuse, like all other cities, has a large extent of roads outside the business portions of the city, and, just as is the case everywhere, these roads cost the city a good deal of money, and are always unsatisfactory to the inhabitants. In these letters the professor takes the ground that the roadways of the streets are far too wide. Not that the streets are too wide, but that the parts devoted to carriage-ways are too wide. His argument is that, no matter what the character of the surface may be, the roadway will be practically worthless unless there is a good foundation. And come to think of it, how often this fact is overlooked or ignored. Ample room for the meeting of two teams is all that is required, and of course it will cost less for such a roadway than for one twice as wide. The city could afford to make these narrow roadways good.

Another reason given for narrowing the roadway is—and we do not remember ever to have heard this argument brought forward before—that in dry weather the narrow roadway presents less surface from which to give off dust to the discomfort of householders and those who pass along the sidewalks.

Then, again, narrowing the roadway will give space for grass between the curbstones and roadway, and this grass will catch and retain much of the dust that would otherwise find its way into houses. The arguments in favor of the narrow roadway appear to be sound.

A New Universal Joint.

The universal joint of which we give an illustration below has recently been brought out and patented by States Machine Co., R. R. Place and Commerce street, Newark, N. J.

FIG. 1.

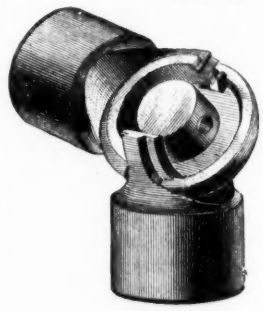


FIG. 2.

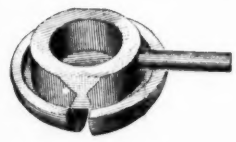


FIG. 3.

It is neat and simple in design, and its wearing surfaces being very large make it a very durable one. Fig. 1 represents the appearance of the joint fitted up completely. It simply consists of two forked sockets, and a ball made in two sections, which are held together by a pin. One section of the ball shown in Fig. 2 has a cylindrical hub, which fits in the cavity bored into the hub on the other section of the ball shown in Fig. 3; the pin projecting from this hub holds the two sections together. The annular spaces around the hubs form one of the grooves in the ball, another groove at right angles to the former one is turned in the ball. In these grooves the forked ends of the sockets work, and since the grooves are of a T form, and the forked ends of the sockets are shaped to correspond, the different pieces of the joint cannot fall apart after they have been put together. All the labor on these joints is tool work, and special tools for the manufacture of these joints have been designed and fitted up by the States Machine Co. For all machine tools requiring universal joints, these are well adapted.

Tandem and Twin Compound Engines.

BY JAMES B. STANWOOD.

Compound engines for stationary purposes are usually either of the tandem or twin type. The twin engine is, however, found in two forms; it may be constructed so as to be self-contained, the bed-plate being in one casting carrying all the bearings, the band wheels overhanging the sides; or it may be built up of two independent engines operating upon one shaft, the fly-wheel being between them. To decide as to which type of engine is the best, involves a number of considerations, as each has special advantages and disadvantages peculiar to itself. A statement of some of these characteristics may well merit attention.

THE LOCATION.

The location to be occupied by an engine is the first important factor bearing upon the type that can be adopted; it affects the problem in two ways; first, as to the amount and distribution of space available, and second, by the influence it bears upon the method of "taking off" the engine's power. Confining our attention to the tandem and the independent twin type, it will be found that the horizontal tandem takes up less floor space than the horizontal twin; the former requires a long and narrow engine-room; the latter a nearly square room. The tandem permits of the driving belts or ropes being led off in any direction, although the best arrangement is to make the engine "run over," and to have the upper belt the "slack" side. This arrangement is about the only satisfactory way that the twin can be operated, as it is never possible to carry the belts back between the cylinders. The twin is therefore limited to this single case, unless vertical belts (a most unsatisfactory device) are employed.

The belts of the tandem can be placed near a wall or partition, and are out of the way; the belts of the twin must pass through the center of the engine-room, though frequently the wheel is of sufficient size to make the top and bottom belts far enough apart vertically, so that the room is not seriously cut up.

Where floor space is extremely valuable, a vertical engine will take up the least room, especially for large powers. The band wheel in such an engine must be placed at one side, and the belt can be led off in any direction. The outboard bearing necessary to support the shaft beyond the band wheel may give trouble, as it is separate from the two or more bearings on the bedplate.

BEARINGS.

This matter of bearings is an important one—thus both the horizontal tandem and twin engines can be built with but two main journals. In the former, one of these bearings, the outboard, can be arranged to be adjusted to the other; it can be raised, or lowered, or moved horizontally, even after the engine is in place, so that the shaft can be kept level and in line, though the foundations settle or the bearings wear unequally. With the twin, conditions are different: both bearings must be placed accurately in line at the start, and must be kept at least always parallel to this position. To line up a pair of engines so that center lines are parallel, square and "out of wind" is a job requiring great care. Foundations for such an engine should be first class, and finally the boxes should be constructed so that the wear can be taken up without throwing the shaft out of parallelism to its original position. The chances for running cool lie with the tandem, though good and careful work secures it also for the independent twin engine.

The self-contained twin does not offer the disadvantages of the independent twin in this regard, as with its two, and often three or four bearings secure on one bed-plate, it is impossible to get badly out of line, as the wear on each bearing is quite uniform. This type is by all odds the best, but it cannot be employed well for large powers, on account of the difficulty in taking the power off; if an outboard bearing is employed, as on the vertical engine, large power can be handled, but then this engine loses one of its most favorable attributes. Otherwise it is particularly well adapted for electric lighting, as with high rotative speeds at least 200 to 300 horse-power can be developed and taken off within a very compact space.

ARRANGEMENT OF CYLINDERS.

The cylinders of the twin engine are by far the most accessible. The back heads can be easily removed, and the pistons are readily gotten at. With a tandem the engineer has a first-class job on hand, if he desires to make an examination of his pistons, especially if the low-pressure cylinder happens to be

nearer the crank; in such a case the engine has to be nearly wrecked to get at the point of interest. When the high-pressure cylinder is nearer the crank, *as it should be*, affairs are not so bad; for then, if there be space enough back of the cylinders, both pistons can be withdrawn if the engine is properly constructed.

The low-pressure cylinder should by all means be accessible, as it is of the utmost importance that its piston be kept tight. Leakage here is a dead loss. This fact has not received the attention it deserves from designers, and the fact that so many tandem engines are constructed with the low-pressure cylinder nearer the crank, tends to bring unnecessary discredit on the type. An engineer will permit the piston and rings to run a long time, often too long, before he attempts to get at them, when to do so means a "big job," or a day or two shut down.

SMOOTH RUNNING.

The tandem, especially if a Corliss compound, is usually a smooth running engine. This is because the compression that can be obtained in the high-pressure cylinder assists in turning the centers smoothly. With the twin, the low-pressure cylinder, when a Corliss, is likely to be noisy unless two eccentrics or some equivalent device is employed for securing ample compression. As to regularity of turning, the twin has every advantage. A lighter fly-wheel can be used, or if the same weight and size be employed to carry the belt as on a tandem of the same power there is less fluctuation in speed each revolution, because the power absorbed and delivered by the wheel is received in smaller amounts, and at more frequent intervals of time. The twin engine has another advantage which permits of the use of higher piston and rotative speed. This is due to the fact that, as its reciprocating parts are much lighter, the effect of momentum and inertia is not so severe on crank-pins and main bearings (especially in engines not counterbalanced), for it can be said that these forces are distributed over two sets of bearings instead of one in the case of the tandem; and if the cranks are quartered, as is usually the case, the times at which these forces act are not synchronous.

COST.

In regard to the cost of the two types of engines, theoretically the twin requires less material than the tandem, or rather there is less needed in the running gear, such as shaft, fly-wheel, etc.; on the other hand, this theoretical advantage is not at all apparent, except on very large engines. Again, an engine of the twin type has to be large, in order to have its greater number of parts of small weight offset in cost the fewer pieces of the tandem of greater weight. Everything thus points to the tandem as being the cheaper engine for moderate horse-powers. The twin engine, if properly "cushioned," can be run at a higher rotative speed than the tandem, for its bearings, having less strain upon them, can be smaller in diameter, and the inertia and momentum of its lighter reciprocating parts are much less. Under these conditions the twin may be the cheaper engine, as more power can be obtained with less material, and in a more compact space (when engine is self-contained) than is the case with the slower moving and more extended tandem. There can be no great hindrance to operating successfully twin engines so constructed, at 800 feet piston speed, or perhaps more, if carefully designed, where with the tandem 600 feet would be fast enough.

ECONOMY IN FUEL.

There seems to be an idea prevalent in some quarters, that the twin engine is more economical in the use of steam than the tandem. On this score it is difficult to make any positive statement; in fact, from any single experiment upon the two types, it would be unsafe to state that, as a class, one is more economical than the other. There may be reason enough, however, for this impression to exist, from the fact that, as a rule, the twin engine is built in larger sizes than the tandem, and also because the greater accessibility of the pistons and cylinders of the former type enable them to be kept in better condition.

Compound Locomotives.*

The slight experience America has had with the compound locomotive, although elsewhere there are between six and seven hundred in successful service, so contracts the possible field to be covered by a report on the subject assigned to us, that we, of necessity, must go beyond the limits of this land and of this association for the major part of our facts; and in expressing opinions and conclusions, are compelled to take for granted a fair acquaintance with its modern literature, giving the experimental results of trials carried on outside the American continent.

To commence with—and as a help in the direction of narrowing the province to be covered by this report—we would suggest for discussion the following questions, viz.: 1st. Is increase of boiler pressure an essential element in the success of compounding? 2d. What gains have followed compounding? 3d. What are said to be its losses? 4th. What, per engine, is the increased first cost of compounding? and 5th. Does the saving more than balance this cost? 6th. What are American conditions for locomotive service, and can the compound locomotive meet them? 7th. Is it an essential defect of the compound that it must be short of starting power? 8th. Give a brief summary covering some details and peculiarities common to compounds.

1st. IS COMPOUNDING OF ANY VALUE WITHOUT INCREASE OF BOILER PRESSURE? This query is due to the repeated assertion that in compounding there was not, and could not be, an economy in steam consumption, except the boiler pressure be decidedly increased, raised to 170 lbs., or even higher. The results of the experiments of Mr. T. Urquhart, locomotive superintendent G. and T. Railway (Southeast Russia), contradict this statement. The trials cover a period of ten months, in the same class of service, with simple and compound engines practically of the same weight, and all with pressures of 135 lbs., and they show for the compounds a general average saving in fuel of 18 per cent.

Apart from this solution of the vexed question of pressure, Mr. Urquhart's experience is unusually interesting, because the experiments were carried out in cold weather, with oil fuel, which has a more uniform heating quality than soft coal; and the delivery of the fuel into the fire-box was almost automatic, thus practically getting rid of the "personal factor," for which it is always necessary to allow in comparing special and brief experiments.

Mr. C. Sandiford, of the N. W. Railway, Lahore, India, reports a 13½ per cent. economy with unaltered, but still lower, pressures, viz., 120 lbs., the saving being the same whether the steam was used in two or four cylinder (tandem) engines.

These results will not surprise those who are familiar with exactly parallel cases in other forms of steam engineering.

Do not misunderstand us to say that there are no economies in higher pressures. There are wide possibilities with high temperature; and the many published figures, from recent trials, stoutly confirm our opinion. But under this leading heading, the committee wished to emphasize the fact that compounding, at ordinary working pressures, has its own value as an economizer of steam, without keeping hid the sister fact that higher pressures give an additional possibility. And it should not be forgotten that very high pressure steam has, so far, only been fully utilized by passage through more than one cylinder.

Higher pressures and very early valve cut-offs, for simple engines, have had a fair trial on many of our railroads; nevertheless, to-day initial cylinder pressures above 150 lbs. are rare; and we believe that when boiler pressures higher than 160 lbs. are retained, it is with the object of making the boiler a reservoir of power for starting and grade climbing, rather than with a confirmed faith that very early cut-offs lower the fuel bill.

The Saxony Railroad report increasing their boiler pressures for simple engines from 8½ to 12 atmospheres (say from 120 to 175 lbs.), without resultant economy; whereas 212 lbs. has not proved too high for convenience or economy in the compound practice of the P. L. and M. Railway (France).

2. WHAT GAINS HAVE FOLLOWED COMPOUNDING? (*a*) It has achieved a saving in the fuel burnt averaging 18 per cent. at reasonable boiler pressures, with encouraging possibilities of further improvement in pressure and in fuel and water economy. (*b*) It has lessened the amount of water (dead weight) to be hauled, so that (*c*) the tender and its load are materially reduced in weight. (*d*) It has increased the possibilities of speed far beyond 60 miles per hour, without unduly straining the motion, frames, axles, or axle boxes of the engine. (*e*) It has increased the haulage power at full speed, or, in other words, has increased the continuous H. P. developed, per given weight of engine and boiler. (*f*) In some classes has increased the starting power. (*g*) It has materially lessened the slide valve friction per H. P. developed. (*h*) It has equalized or distributed the turning force on the crank-pin, over a longer portion of its path, which, of course, tends to lengthen the repair life of the engine. (*i*) In the two-cylinder type it has decreased the oil consumption, and has even done so in the Woolfe four-cylinder engine. (*j*) Its smoother and steadier draught on the fire is favorable to the combustion of all kinds of soft coal; and the sparks thrown being smaller and less in number, it lessens the risk to property from destruction by fire. (*k*) These advantages and economies are gained without having to *improve* the man handling the engine, less being left to his discretion (or careless indifference) than in the simple engine. (*l*) Valve motion, of every locomotive type, can be used in its best working and most effective position. (*m*) A wider elasticity in locomotive design is permitted; as, if desired, side rods can be dispensed with, or articulated engines of 100 tons weight, with independent trucks, used for sharp curves on mountain service, as suggested by Mallet and Brunner. One such engine of 80 long tons is now under construction.

3. WHAT LOSSES ARE SAID TO HAVE FOLLOWED COMPOUNDING? (*a*) In some particular types, as actually proportioned, a loss in starting power of from 15 to 20 per cent. However, loss of power in starting cannot be said to be a defect in the principle of compounding. (*b*) An increase in the number of parts. They are few and plain in the two-cylinder engine, entailing little outlay in first cost or in repair. (*c*) A possible, but, this committee thinks, not probable increase in the cost of repairs to the boiler, per pound of fuel burnt, if higher pressures are used. Positive information on this point is difficult to obtain. (*d*) An increased cost of repairs to the engine per mile run. This item is not yet large enough to be measurable, after three years' continuous service in the plainer forms of the two-cylinder compounds. (*e*) A larger percentage of failures on the road due to greater complication and size of parts. (*f*) Increased reciprocating weights on one side, either not balanced, and so increasing the deflection of the engine, or, if approximately balanced, the balance weight doing injury to the road bed, etc. The two last sections seem to be pure suppositions, which, after search, we find no evidence to sustain. (*g*) Want of variability or adaptability to wide extremes in speed, and to amount of work to be performed; so that a large compound does not work as cheaply when hauling light loads, or running without load, as a single engine does.

It is not proved that a compound, working properly throttled, that is, with steam wire-drawn, may not have actually, as she theoretically has, a wide and economical adaptability. So that if the compound, like any other motor, be not as economical when exerting low power as when exerting full power, it probably will use less steam than the simple engine of same weight, working under similar conditions of light haulage duty.

However, the one thing certain about "American conditions" is that no large portion of our motive power does run lightly loaded, and until we have a wider experimental experience, it is not recommended that all locomotives, doing branch and local light service, be built compound.

4th. WHAT IS THE INCREASED FIRST COST PER ENGINE? M. V. Borries has published figures giving cost. In speaking of his own design of engine, he says they can "be built 2 to 5 per cent. cheaper than single engines of the same power—not of the same maximum tractive force; because this power depends upon the boiler, which might be 10 to 15 per cent. smaller for the compound engine. If the same boiler is kept, as is commonly the case, the compound engine would be some 2 or 3 per cent. heavier, and 4 or 5 per cent. more costly than a simple one; but, with properly dimensioned cylinders, 10 to 15 per cent. more powerful than the latter. For equal work the compound engine would always be the cheaper engine." Mr. E. Worthington says: "The intercepting valve and copper pipes forming the receiver, and the patterns for two different sizes of cylinders, are the chief items which raise the cost of a two-cylindered compound locomotive; while engines with three or more cylinders have additional parts, which considerably increase their cost. In engines with four cylinders, the tandem system is cheaper than the receiver system. Tandem cylinders are, however, objectionable, because the pistons are difficult to examine; but the receiver system is ready of access, and affords an opportunity of heating the intermediate steam by circulating it among the waste gases of the smoke-box; and, by isolating the high-pressure and low-pressure cylinders, an advantageous difference of temperature is maintained between them."

"The cost of constructing a number of two-cylindered locomotives does not greatly exceed that of the same number of ordinary engines. The cost of three-cylinder locomotives may exceed that of simple engines by $1,000 to $1,250 each."

The cost of changing simple to two-cylinder engines need not exceed $250 to $300 each, if the expense of drawings, patterns, and templates be divided over a series of engines. The additional cost of building a two-cylinder engine, with receiver, etc., as used by the M. C. Railway, or the ingenious form of four-cylinder engine, as used by the B. & O. Railway, need be little, if anything, over $200 (excluding royalties), or say from 2 to 2¼ per cent. increase on the cost of a simple engine.

5th. DOES THE SAVING MORE THAN BALANCE THE INCREASED FIRST COST? If, for convenience, the fuel saving be taken at 17 per cent., or 1-6, and the gross consumption at 900 tons per year, with coal at $1.50 per ton, the decrease in the annual fuel bill is but $225. Certainly not a wide margin to cover contingencies. If, however, at first only the more powerful engines are compounded, whose consumption averages 1,200 tons per year, and coal, as is common, costs on tender $3 per ton, the saving on fuel is $600, or two cents per mile on a mileage of 30,000 per annum. As this amount would cover not only reasonable interest on first cost, but also allow for about 33 per cent. increase in total expenditure for motive power, repairs and renewals, the saving is certainly enough to permit a possible, but, we think, not a probable, largely increased cost of engine repairs, and yet have a margin of saving on the final balance sheet to the credit of the compound.

6th. WHAT ARE "AMERICAN CONDITIONS" FOR LOCOMOTIVE SERVICE? CAN THE COMPOUND ENGINE MEET THEM? We have given this section a large amount of attention, because it has so often been said that the compound must, to be successful on this continent, be adapted to suit American conditions, and your committee naturally were desirous of fully understanding these conditions. They have not been specified by those making the assertion; and we must reluctantly confess to having failed to identify, much less define them, so that, after a long, unsatisfactory chase, they appear to us to be somewhat mythical. If any member can, and will, specify them, he will confer a favor, at least upon the committee, if not upon the association.

* Report of a Committee of the American Railway Master Mechanics' Association at the Old Point Comfort Meeting, June 17.

If an American condition be large starting power, then the Malett two-cylinder and all four-cylinder engines easily have cylinder power in excess of their adhesive weight. If American conditions be ability to do satisfactory work on a second-rate or third rate road bed, or simplicity of construction, or easy accessibility of parts, then these conditions are met by any two-cylinder engine, or by the B. & O. Railway four-cylinder engine.

Apparently neither climate nor men are factors in this equation, as compounds are a success in the hands of ordinary enginemen in partially civilized countries; and in hot climates, as well as in Russia, under conditions of low temperature and snow as trying as those ordinarily met with inside of 51 degrees, the present northern limit of our railway belt.

7th. IS IT AN ESSENTIAL DEFECT OF COMPOUND LOCOMOTIVES THAT THEY MUST BE SHORT OF STARTING POWER? Certainly not! The starting power of the Malett type is at least equal to that of a simple engine of the same weight, and its cylinder power can easily be made to exceed it, by allowing more than half boiler pressure in the large cylinder for the first few revolutions. In the V. Borries, Worsdell, Pitkin and other two-cylinder types, and the Lepage three-cylinder engine, their starting power (as Prof. Woods has graphically illustrated), at 170 lbs., may be greater than that of a simple engine at 150 lbs., having cylinders of the same size as the high pressure, *during the first half revolution*, but that after this the power (at low speed) of the compound diminishes to 80 or 85 per cent. of that of the simple engine. This conclusion is modified and improved by the knowledge that all two-cylinder engines originally designed as compounds have, or should have, their small cylinder larger than the cylinder of the simple engine of corresponding weight or duty.

It is possible, with the Lindner or equivalent form of starting valve—and a painstaking engineman—to get about 90 per cent. of the starting power of a corresponding simple engine. The Webb type of three-cylinder engine (except with the low-pressure crank dead on center) has cylinder power enough to slip both pairs of wheels, and no higher starting power is desirable. What may be called the opposite form of three-cylinder engine (the Sauvage type), with cylinders of approximately the same diameter, as used on the Northern Railway of France, has ample starting power, because the full boiler pressure is admitted direct to the two low-pressure cylinders. In fact, if desired, the locomotive can be continuously so worked, viz., as a simple engine. Tandem and other forms of four-cylinder engines are not wanting in starting power. The B. & O. Railway engine in starting, with a gear as simple as the water-tap gear, puts the small piston practically into equilibrium, and thus admits high-pressure steam to the large cylinder.

A mean effective pressure of 90 lbs., in a simple 18x24 in. engine, will start a train of 13 coaches on a level in a lively fashion, and a compound can easily give the equivalent of that total pressure, without being over-cylindered.

Going back to the two-cylinder style of engine, with automatic intercepting valve, and limited size of cylinder, it would seem as if all of them were capable of getting into motion the load they were designed to haul at full speed, so that their limitations are that they do not get away quite as smartly, quite as noisily, or with the same tearing effort on fire and fire-box, as do certain simple engines that waste both fuel and steam in starting. The comparative difference, in time or distance, required by this class of compound to attain maximum speed, has not yet been shown by experiment, but is probably less than is generally supposed.

Mr. Urquhart, desiring to settle the question of the tractive power of simple engines altered to compound, with one cylinder unchanged, and with boiler pressure unchanged, carried out tests, using both indicator and dynamometer; and he reports that at a speed of 10 miles per hour the compound passenger engine suffered the following diminution, viz., in first notch, 42 per cent; in second notch, 28 per cent.; in third notch, 17 per cent.; in fourth notch, 7 per cent.; and in fifth notch, or full gear, 5 per cent. And a similar test of the freight compound showed, in the first notch, 27 per cent. loss.; in the second notch, 17 per cent.; in the third notch, 10 per cent.; and in the fourth notch, or full gear, 5 per cent. He goes on to say that, for all practical purposes, in full gear a five per cent. difference, at this speed, may be neglected.

8TH. GENERAL.—A recent press notice credits Mr. Webb with an attempt to reduce first cost, by throwing away the valve gear for the low-pressure cylinder, and using in its place a single loose reversing eccentric—in other words, with an attempt to use an invariable cut-off for the large cylinder. And such practice is not unreasonable, if it from the first be acknowledged that the compound is designed for doing a maximum specific duty with high economy, and, therefore, the valve gear cannot be, and is not, arranged for a wide variability of service.

This intention in design most clearly marks all those engines using but one valve, or one valve stem, to distribute the steam to both high and low-pressure cylinders; such, for instance, as the Vauclain piston valve, the Woolfe hollow D valve, and the Dunbar single valve stem. In the two first mentioned most ingenious valves, the release of the high-pressure cylinder must be at the same moment as the admission to the low-pressure, or it is no actual release; and the cut-off in the low-pressure cylinder marks the exact point when compression in the high-pressure cylinder commences, there being no appreciable "receiver" capacity in the valves themselves, large as the passages through them have to be. There is, then, it is clear, little elasticity of adjustment in such valves and gears. The cut-off being early in the small cylinder, it must be early in the large, and as a result the compression in the small cylinder is enormous. Thus the conclusion is again brought home to us that the control of the compound, when small horse-power is to be developed, must be chiefly through the throttle wire-drawing in the steam, and thus reducing the initial pressure.

Putting emphasis on this truth will not frighten those who are familiar with the fact that wire-drawing is common to-day with our best enginemen. And it may here be noted that the *imperative necessity* for this so-called "crude practice" is the full explanation for the slight use in modern locomotives of screw and other finely divided reversing gears. This statement opens up the whole matter of cylinder condensation, but it is too large a matter to be properly treated in this report.

However, such modern experimenters as Westinghouse, Kennedy, etc., prove that wire-drawing the admission into cylinders of large surface and small volume is more economical than valve cut-offs at less than 50 per cent. of the stroke.

There are some constructive details and peculiarities about compounds that may deserve special mention. For instance, it is judicious to put safety or relief valves on the low-pressure chest or cylinder, but they should be so located or guarded that in case they came into action they should not smother the engineman with steam and obscure his vision. All types do not require water-taps on both cylinders, but most receivers should be so drained. If an intercepting valve is used a reducing valve is not required, and if an intercepting valve is not used there must be a valve to give independent exhaust direct to the atmosphere from the high-pressure cylinder. The weight of evidence, so far, is in favor of the use of an intermediate receiver. Such a device effectually isolates the cylinders, so that each retains its distinctive temperature. The general practice of drying the intermediate steam by putting the receiver in the smoke-box has much to recommend it. Copper pipes, set close to the curve of the smoke box, are not cumbersome, or much in the way; and if it be desired that the feed water also be heated in the smoke-box, the large receiver pipes need not interfere with the details of such an arrangement. Receiver capacity cannot, under our limiting conditions, be too large. It should never be less than 1½ times the volume of the high-pressure cylinder, and 2 or more volumes are desirable; because, with a liberal receiver, the steam supply to the low-pressure cylinder is more uniform in pressure and amount, the re-heating or drying of the steam is more thoroughly done, and "the drop" in pressure between high-pressure final and low-pressure initial is less detrimental to steam economy.

If one side of a compound should break down the other side can be run as a single cylinder engine, if the failure is not due to a total collapse of the cylinder on the side to be blocked. And in a tandem, as in a simple engine, the failure on one side may be a total collapse, without its interfering with the use of the other side as a single engine.

J. DAVIS BARNETT,
JOHN PLAYER,
H. D. GARRETT,
F. W. DEAN.

DISCUSSION.

In discussing this paper Professor A. T. Woods, who was introduced by the secretary, said: I am in favor of compound locomotives. Our friends on the other side of the water have been making experiments, which carry out just what we expect as a result of compounding. They have invariably made a saving by adopting the compound system. I have been unable to get at the records of one compound engine, that was a failure in this country, on the Boston & Albany road. A good many of the arguments being brought forward by the opponents of the compound system are almost exactly in the same line as were used with regard to the marine engine fifteen years ago. They are using triple and quadruple expansion engines to-day. The increase in the number of cylinders has been accompanied by an increase in boiler pressure, but it does not seem to be necessary to increase pressure in the locomotive in order to gain by compounding. Indeed, compounding has been found to produce economies, even when pressures of 125 to 135 pounds are used. As the report has shown, there is no difficulty in the starting power when properly designed. The compound locomotive is not as flexible as the simple engine. You cannot have as wide a range. But if you are to get economical results the engine must be designed for the work it is to do. If you want a freight engine for slow speed, heavy work, there is no reason why you cannot get just what you want. But it is not expected to put a compound designed for passenger work on another class of work and get as good results.

Mr. Barnes—I would like to ask Professor Woods to explain what he means by the lack of range in the compound as compared with the simple engine, whether in range of economy or in working?

Professor Woods—I mean simply a question of economy. I see no reason why a compound engine would not work wherever a simple one will. But the only object in using compound engines is for economy. In any class of work in working for economy you must understand what the work is to be.

The President—Do you know anything about the defects in the Boston & Albany compound, Mr. Pitkin?

Mr. Pitkin—It is a tandem engine, having a small cylinder forward of the large one. I understand that the engine did not quite meet the expectations of the designer, and I am inclined to think the trouble was in a defect in the designing. The openings passing from the one cylinder to the other were only about two and one-half inches in diameter. Great condensation would take place. I am inclined to think that while I believe thoroughly in the two-cylinder type as the proper form, there would have been great economy with that engine had the cylinders been properly designed.

The secretary, at the request of Mr. Meehan, here read the following letter:

June 12th, 1890.

J. G. METCALFE, Esq., General Manager.

DEAR SIR: In answer to yours of the 2d inst., asking if I would recommend the purchase of compound engines, I would respectfully reply. I would not at present recommend such purchase, my reasons being that the compound locomotive has not yet been perfected to its possibilities; nor do I believe that it will ever do all that is claimed for it. At the same time there are enough ready to build and try these engines which will develop the defects, as well as demonstrate their value. This will give later entries in the field points to design from more intelligently. While the compound principle has proven a full success as applied to condensing engines, we are trying to obtain the same results under altogether different conditions; first, in the condensing engine they are enabled, by using different areas, to expand a high pressure steam down to a point where it is practicable to condense it economically, that is, without overloading the air-pump, thereby getting the full benefit of expansion, besides getting a large area of piston for the vacuum to work on. In this way they get the benefit of high pressure expanded to the utmost, and the same result from vacuum as they would on a single cylinder of the same diameter as their largest, and stroke enough to contain the value of both, or three if triple, besides less loss from radiation and consequent condensation of their live steam.

The differences in conditions are, that we have to maintain a back pressure of about 16 pounds, for the purpose of exhaust to fan our fires, but the principal thing to be decided is the proportions or ratio of cylinders. You will have noticed the different writers vary in their recommendations, from the same size of cylinder for high-pressure, to one inch larger than a simple engine for same power, but in the low-pressure they vary from two and one-tenth to three. This comes from the fact that each of these various proportions suits certain conditions, and a compound engine proportioned for certain work is most economical when doing just that work, and its economy decreases as you vary from that point. This arises from the fact that, as the mean effective pressure in high-pressure increases, you need just that much more volume or area in low-pressure to expand and *vice versa*, thus: we will take a high-pressure cylinder of the same diameter as simple engine, say 20 inches, although the diameter has no bearing on the principle. Now this cylinder will exert just the same power as the same cylinder less the back pressure on its own area at the mean effective pressure in low-pressure cylinder, which, if steam was admitted full stroke, and the other cylinder was to do the same work, would be just one-third the boiler pressure. Thus if we admitted one hundred and fifty on one side of small piston she would expand into three volumes, or fifty pounds on the low-pressure cylinder, hence you would have a pressure of one hundred and fifty pounds on one side of your high-pressure piston opposed by its own area at fifty pounds, but you would have fifty pounds pressure on twice the area of this piston doing its work in large cylinder. Thus, the power of your compound at one hundred and fifty, admitting steam full stroke, would be the area of the small piston multiplied by mean effective pressure of one hundred pounds added to the area of large or low-pressure piston multiplied by mean pressure, or fifty pounds. Thus the power of a compound would be, area 314.15 x pressure 100 x stroke 24 area 626.32 x 50 x stroke 25, 1,507,968 lbs. of power. A simple engine of same diameter 20 in. would give area 314.16 x pressure 150 x stroke 24, 1,130,976 lbs. of power with the same volume of steam, no allowance being made for terminal back pressure, all this being one stroke only, and an impossibility in practice being introduced only to demonstrate the difference in results to be obtained under certain conditions. As you will note, the power given above is for a complete compound engine with two cylinders, while the other is only one-half of a simple engine, but has used the same amount of steam, and demonstrates that, disregarding the economy, and using all the steam needed to make two strokes of the piston in simple engine the same as has been in compound. You

(*Continued on page* 12.)

Odontics, or the Theory and Practice of the Teeth of Gears.

BY GEO. B. GRANT.

EIGHTH PAPER.

82.—THE THREE POINT ODONTOGRAPH.

It is a simple matter to draw the tooth curve by means of rolling circles, but such a method requires skill on the part of the draftsman. It is, moreover, nothing but a method for finding points in the curve for which approximate circular arcs are then determined.

The "three point" odontograph is simply a record of the positions of the centers of the circles which approximate the most closely to the whole curve of the standard tooth. The positions of two points, a at the center of the face or of the flank, Fig. 60, and b at the addendum point or root point of the curve, were carefully computed, and then the position of the center C of the circle which passes through these two points and the pitch point O, was calculated. The circle that passes through these three points is assumed to be as accurately approximate to the true curve as any possible circular arc can be.

The odontograph gives the radius "rad." of the circular arc, and the distance "dis." of the circle of centers from the pitch line, for the tooth of a given pitch, and their values for other pitches are easily found by simple multiplication or division.

The advantages of this method lie in the facts that the desired radius and distance are given directly, without the labor of finding them, and that as they are computed they are free from errors of manipulation. In point of time required, the advantage is with the odontograph in the ratio of ten to one.

The greatest error of the odontographic arc, shown greatly exaggerated by the dotted lines, is at the point c on the face, and it is greater on a twelve-toothed pinion than on any larger gear. For a twelve-toothed pinion of three-inch circular pitch, a large tooth, the actual amount of the maximum error is less than one one-hundredth of an inch, and its average for eight equidistant points on the face is about four-thousandths of an inch. Any error that is greater than that stated will be due to manipulation, and not to the method.

83.—USING THE ODONTOGRAPH.

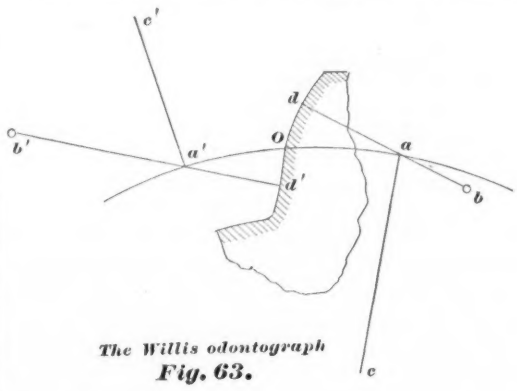
To apply the odontograph to any particular case, first draw the pitch, addendum, root, and clearance lines, and space the pitch line, Figs. 60 and 61.

Then draw the line of flank centers at the tabular distance "dis." outside of the pitch line, and the line of face centers at the distance "dis." inside of it. Take the face radius "rad." on the dividers, and draw in all the face curves from centers on the line of face centers; then take the flank radius "rad." and draw all the flank curves from centers on the line of flank centers.

The table gives the distances and radii if the pitch is either exactly one diametral or one inch circular, and for any other pitch multiply or divide as directed in the table.

Fig. 61 shows the process applied to a practical case, with the distances given in figures.

Fig. 62 shows the same process applied to an internal gear of twenty-four teeth working with a pinion of twelve teeth. It illustrates secondary action and double contact. It also shows the actual divergence of the Willis odontographic arc from the true curve.



The Willis odontograph
Fig. 63.

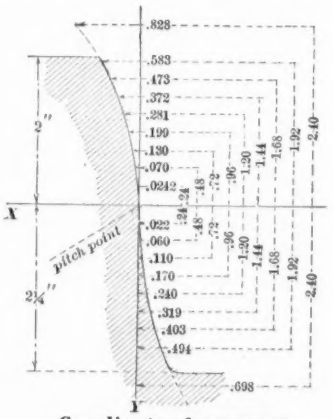
84.—THE WILLIS ODONTOGRAPH.

This is the oldest and best known of all the odontographs, but it is inferior to several others since proposed, not only in ease of operation, but in accuracy of result.

To apply it, find the pitch points a and a' half a tooth from the pitch point O, Fig. 63, draw the radii $a\ c$ and $a'\ c'$, lay off the angles $c\ a\ b$ and $c'\ a'\ b'$, both 75°, and lay off the distances $a\ b$ and $a'\ b'$ that are given by a table.

The centers b and b' thus found are the centers of circular arcs that are tangent to the tooth curves at d and d'. The dividers are set to the radius $b\ O$ or $b'\ O$ to draw the curves.

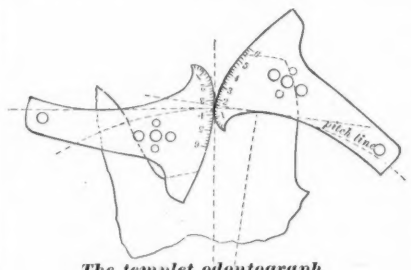
The Willis arc touches the true curve only at the pitch point O, and its variation elsewhere is small, but noticeable. On the face of the tooth of a twelve-toothed pinion of three inch circular pitch, its error at the addendum point is four-hundredths of an inch, and it will average three times that of the three point method (82). The error is shown by Fig. 62.



Coordinate odontograph
Fig. 64.

The greatest error of the method is due to manipulation. The angle is usually laid off by a card, and the center measured in by a scale on the card. The circle of centers is then drawn through the center, and unless great care is used the chances of error are great.

The angle $90° - c\ a\ b = W = \frac{180}{s}$, and the distance $a\ b = \frac{s\ c}{2\ \pi} \cdot \frac{t}{t \pm s} \sin. W$, in which s is the number of teeth in the gear of the same set which has radial flanks, usually 12; c is the circular pitch, and t is the number of teeth in the gear being drawn. The positive sign is used for the face radius, and the negative for the flank radius.



The templet odontograph
Fig. 65.

85. — KLEIN'S CO-ORDINATE ODONTOGRAPH.

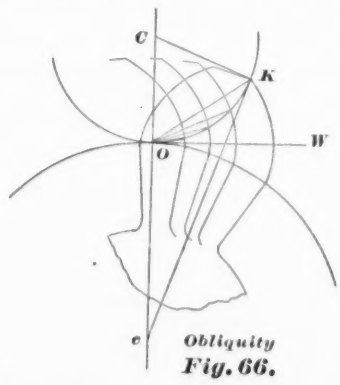
This is a method of finding the positions of several points on the tooth curve by means of their co-ordinates referred to axes through the pitch point. Any point on the curve is found by laying off a certain distance on the radius Y, Fig. 64, and then a certain distance at right angles to it, the distances being given by a table for a certain standard tooth.

As many points as required are found by this method, and then the curve is drawn in by curved rulers, or by finding the approximating circular arc.

This odontograph is to be found in Klein's Elements of Machine Design.

86.—THE TEMPLET ODONTOGRAPH.

Prof. Robinson's templet odontograph is an instrument, not a method. It is a piece of sheet metal, Fig. 65, having two edges shaped to logarithmic spirals. It is laid upon the drawing, according to directions given in an accompanying pamphlet, and used as a ruler to guide the pen. It can be fastened to a radius bar, and swung on the center of the gear, to draw all the teeth. See Van Nostrand's Science Series, No. 24, for the theory of the instrument in detail.



Obliquity
Fig. 66.

87.—OBLIQUITY OF THE ACTION.

When the point of contact between two teeth is at the pitch point O, Fig. 66, the pressure between the teeth is at right angles to the line of centers, but, as the point of contact recedes from the line, the direction of the pressure varies by an angle of obliquity which increases from zero until the point K, at the intersection of the addendum circle with the line of action, is reached.

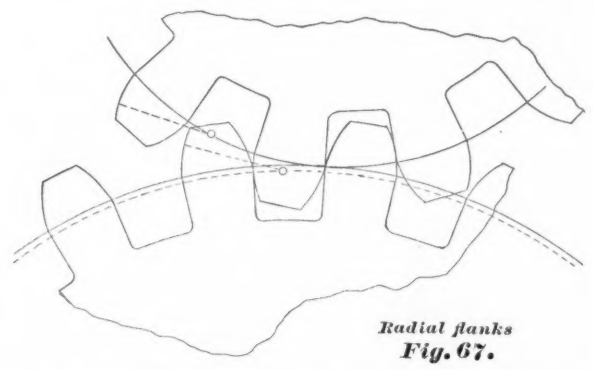
The angle $K = K\ O\ W$, of the maximum obliquity, can be found by solving the triangle $C\ c\ K$, and for the standard set we have,

$$cos.\ 2\ K = \frac{2\ n + 17}{3\ n + 18},$$

in which n is the number of teeth in the gear.

For the smallest gear of the set, the one having twelve teeth, K is 20° 15′, and for the rack it is 24° 5′, so that it will always be between those two limits for external gears, and greater for internal gears.

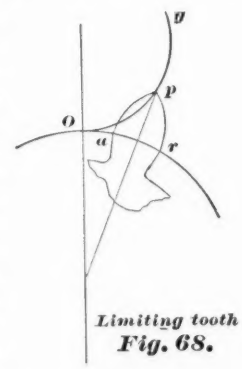
The friction between two gear teeth increases with the angle of obliquity, but not in direct proportion. With the involute tooth the work done while going over a certain arc from the line of centers is proportional to the square of the arc, and for cycloidal teeth the increase with the arc is still more rapid. Therefore it is the maximum obliquity of the action that principally determines the injurious effects of friction.



Radial flanks
Fig. 67.

88.—THE CUTTER LIMIT.

When the number of teeth in the gear is less than that in the gear having teeth with radial flanks, the flanks will be under-curved, and when too much so they cannot be cut with a rotary cutter. The teeth of Fig. 55 could not be cut with a rotary cutter beyond the points where the tangents to the two sides are parallel.



Limiting tooth
Fig. 68.

The limit is reached when the last point that is cut by the rotary cutter is also the last point that is touched by the tooth of the rack in action with it, not allowing for internal gears.

The diameter of the gear when this limit is reached is found by the formula,

$$D = 2d - \frac{c}{2\ sin.^{-1} \sqrt{\frac{a}{d}}}$$

in which D is the diameter of the gear, d is the diameter of the circle of action, c is the circular pitch, and a is the addendum.

For the common addendum of unity divided by the diametral pitch this may be put in the shape,

$$n = s - \frac{\pi}{2\ sin.^{-1} \sqrt{\frac{2}{s}}}$$

in which s is the number of teeth in the radial flanked gear, and n is the number in the required cutter limit.

For the common series, where $s = 12$, we have $n = 8.26$; and for the cutter standard of $s = 15$, we have $n = 10.80$, so that cutters could easily be made to cut gears with less than s teeth.

89.—RADIAL FLANKED TEETH.

When the rolling circle for the faces is of half the diameter of the pitch line of the mating gear, the flanks of both gears will be straight radial lines, as in Fig. 67.

Such gears are fitted to each other in pairs,

THREE-POINT ODONTOGRAPH.

STANDARD CYCLOIDAL TEETH.

INTERCHANGEABLE SERIES.

From a Pinion of Ten Teeth to a Rack.

NUMBER OF TEETH IN THE GEAR.		For One DIAMETRAL PITCH. For any other pitch divide by that pitch.				For One Inch CIRCULAR PITCH. For any other pitch multiply by that pitch.			
		Faces.		Flanks.		Faces.		Flanks.	
Exact.	Intervals.	Rad.	Dis.	Rad.	Dis.	Rad.	Dis.	Rad.	Dis.
10	10	1.99	.02	— 8.00	4.00	.62	.01	−2.50	1.30
11	11	2.00	.04	−10.50	6.50	.63	.01	−3.20	2.15
12	12	2.01	.06	∞	∞	.64	.02	∞	∞
13½	13—14	2.04	.07	15.10	9.43	.65	.02	4.80	3.00
15½	15—16	2.10	.09	7.86	3.46	.67	.03	2.50	1.10
17½	17—18	2.14	.11	6.13	2.20	.68	.04	1.95	.70
20	19—21	2.20	.13	5.12	1.57	.70	.04	1.63	.50
23	22—24	2.26	.15	4.50	1.13	.72	.05	1.43	.36
27	25—29	2.33	.16	4.10	.96	.74	.05	1.30	.29
33	30—36	2.40	.19	3.80	.72	.76	.06	1.20	.23
42	37—48	2.48	.22	3.52	.63	.79	.07	1.12	.20
58	49—72	2.60	.25	3.33	.54	.83	.08	1.06	.17
97	73—144	2.83	.28	3.14	.44	.90	.09	1.00	.14
290	145—300	2.92	.31	3.00	.38	.93	.10	.95	.12
∞	Rack	2.96	.34	2.96	.34	.94	.11	.94	.11

and are not interchangeable with other sizes. Their teeth are more easily made than those of standard gears. The maximum obliquity is less, but the strength of the teeth is also less than usual. There is no reason for making such teeth in preference to the standard, although, for that reason probably, they are used to a considerable extent. It would be difficult to devise a form of tooth so whimsical that it would find no one to adopt and use it.

90.—THE LIMITING NUMBERS OF TEETH.

When the number of teeth in a driving gear is small, the point p, Fig. 68, of its pointed tooth may go out of action by leaving the line of action $O\,g$ before a certain definite arc of recess $O\,r$ has been passed over, and the problem is to find the smallest number of teeth in the following gear that will just allow the given recess.

This question, which is not a particularly important one, is discussed at length, and applied to both bevel and spur gears, in either external or internal contact, in an article in the "Journal of the Franklin Institute" for Feb., 1888, and we will here consider only the case of the common spur gear.

The recess $O\,r$ is given as a times the circular pitch, and the thickness $a\,r$ of the tooth is given as b times the same. The diameter of the circle of action is q times that of the pitch line of the following gear. The number of teeth in the driving gear is d, and the number in the following gear is f. M is an auxiliary angle equal to $\frac{360\,a}{q}$, and W is an angle $\frac{360}{d}\left(a-\frac{b}{2}\right)$.

Then the required number f can be found by a process of trial and error with the formula,

$$\frac{sin.\,(M+W)}{sin.\,W}-\frac{d}{q\,f}-1=0.$$

For an example, let the recess be $\frac{3}{4}$ of the pitch, the tooth equal to the space, and the flanks of the follower to be radial. Let the problem be to find a follower for a driver of seven teeth. This gives $a=\frac{3}{4}$, $b=\frac{1}{2}$, $q=\frac{1}{2}$, $d=7$, and the formula becomes

$$\frac{sin.\left(\frac{540^\circ}{f}+25^\circ\,43'\right)}{sin.\,25^\circ\,43'}-\frac{14}{f}-1=0.$$

If we put f at random, at 20, we shall get, $+.134=0$. Next, trying $f=10$, we get $-.132=0$, and the opposite signs show that f is between 20 and 10. Trying 12 the result is positive, and for 11 it is negative, showing that 12 is the required value of f. That is, 7 teeth will not drive less than 12 teeth with radial flanks, unless it is allowed an arc of recess greater than $\frac{3}{4}$ of the pitch.

For another example, test MacCord's value of 382 as the least driver for a follower of 10 teeth, when recess equals the pitch and the follower has radial flanks. Trying $d=382$, the error is negative; for 383 it is also negative, but for 384 it is positive, and therefore the latter is the true number.

Extensive and sufficiently accurate tables of limiting values are given by MacCord in his "Kinematics."

LETTERS FROM PRACTICAL MEN.

A Follow Rest.

Editor American Machinist:

I believe I have made a statement that I have never seen a good follow rest—one that will answer different conditions. I have used one lately which did good service for a certain class of work. I take the liberty to describe this to the readers of the AMERICAN MACHINIST. If they choose to try it, and have as good success as I had, I think they will be pleased. Some shops would consider a little matter of this kind beneath their notice, but my experience has taught me that the little non-expensive tools are of the most importance after all.

I used this rest for cutting long, slender screws, but I show a bushing and gauge for turning long shafts. The one I used was only a temporary affair, and was taken from the "scrap-box," where it was afterwards returned, for the "boss" thought such an affair beneath his notice. Of course the base of the rest must be made to suit the design of lathe you choose to use it on. It should be rigidly attached to the carriage. Fig. 1 shows the form of the top. It should be cast with the recesses through to the core. A convenient way of boring this in place (if you have not got a good boring bar handy) is to take an ordinary stout lathe boring tool, and hold it in a good four-jawed chuck; you can throw the point off center by screwing the jaws, and so bore the hole to the size you want.

Fig. 2 shows the bushing, which I found worked best made of cast-iron. I made one of steel, hardened and ground, but found it of no account whatever. It kept continually "rutting up," which wasted lots of time, and unnecessary language. I threw it into the "scrap-box," made one of cast-iron, and was happy. It should be an easy fit on the shaft. With this rig it need not make any difference how long or slender a piece—"it gets there just the same."

Of course there are places where this will not work, such as a very small rod, where the thread has to be cut close to a shoulder. In this case we would have to use the tool in the front end of bushing, and if the rod is too small to allow the bushing to go over the tail center we could not get back.

Fig. 3 shows the end of bushing for turning long shafts. This bushing should project about a quarter of an inch beyond the rest, and be cut through, as shown at A, to allow the gauge (Fig. 4) to enter. The tool should cut its size very close to end of bushing. We should use a roughing tool ahead of this, to make the shaft within about .01 of size. The gauge shown, I think, is much better than one made with one standard size, for with this you can know something of how much variation there is.

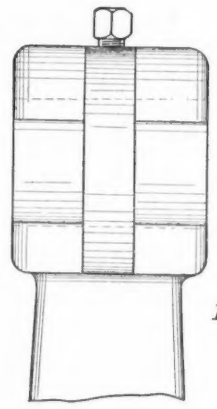


Fig. 1.

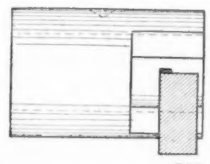


Fig. 2.

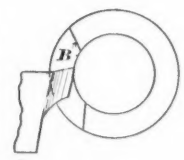


Fig. 3.

A FOLLOW REST.

In cutting some long half V screws, I have used with advantage two tools, one ahead of the other, to cut out the square bottom. I can show a double tool holder (if any one is interested) to bolt to tool block, so that the tools will have independent slide motions.

The idea in cutting the angle shown at B, in Fig. 2, is to brush off the chips.

A MECHANIC.

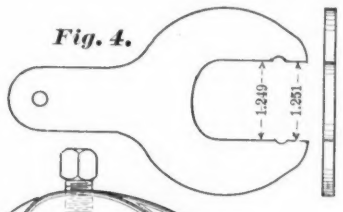
Kerosene in Boilers.

Editor American Machinist:

Regarding the use of kerosene in steam boilers, for the purpose of removing and preventing scale, I offer the following, founded on practical usage of the same. The boiler was an ordinary return tubular, without a mud drum, and with feed water entering above the tubes at front head, and continued to within three feet of back head. The water was from a drilled well in limestone, and contained sulphate and carbonate of lime and magnesia. Owing to the fact of it costing something, I could not induce my employers to have an analysis made, so I made a rough one myself to determine what was contained, rather than how much. I began using the oil with boiler clean, and with new tubes. I ran two weeks, using one pint per day, and opened up for examination. I found the tubes distinctly greasy, while that part of the shell over the furnace, and perhaps three feet beyond the bridge, seemed free from oil. On the sheet where traces of oil could be found there was no new scale forming, while over the furnace scale had settled $\frac{1}{16}''$ thick. The boiler being cold, I put in one gallon, filled up, and ran two weeks again, using a 3″ blow-off every morning, and one pint of oil per day. Opening, I found things as at first, the scale on bottom sheets increasing, and being very hard. After two hours hard work with the noted Armstrong scale remover, I painted the lower sheets with oil, put in one gallon, and ran two weeks more, with like results. The heat at bottom of shell seemed to vaporize the oil, and, while the tubes were kept fairly clean, yet there was an unusual amount of scale where the most damage could be done.

I cannot affirm that kerosene will evaporate entirely in steam, although from its volatile nature one would judge such to be the case. I have found the oil floating on the water on opening to clean, and I had put the last charge in forty-eight hours before, the boiler having been in service for twenty hours after last charge. I then began the use of a salsoda and tannic acid compound, using oil two weeks, and then the compound, and this combination seemed to suit the disease, as it removed and prevented the scale.

Fig. 4.



Where a boiler is badly scaled I would advise the use of kerosene as perhaps the quickest, and certainly the least harmful of scale solvents. The water should be allowed to run out hot—but without pressure—and the boiler should stand until the scale is free from water, when the oil may be freely painted on the accessible parts, and a proper amount put in, the boiler then being slowly filled up. The blow-off should be used freely during the run. No one can formulate a rule applicable to varied conditions, and one must develop, and depend on their own judgment.

I have read that the use of oil was wrong, because it destroyed the adhesion between the laps of sheets at the seams. Fortunately we find this does not appear where good workmanship obtains, and should your boiler start to leak after using oil, you may be sure the same result would be obtained by any solvent that removed the scale.

I like the use of kerosene for other reasons also; it keeps pipes clean, does *not* neutralize the oil in cylinders, piston rods and valve stems packings wear better, while corrosion is stopped.

I should prefer refined oil to any heavy product, as the latter, in combination with the scale, is liable to form a sludge heavier than the water, and, settling on the sheets, would allow them to become overheated.

Where an open exhaust heater is used—and with it cylinder oil free from animal oil—a less amount of kerosene is needed than with a closed heater.

Don't expect any solvent to get out a search warrant for every atom of scale, serve it, and promptly eject the culprit. Solvents are not "built that way." If it does part of the work, do the other part yourself. Wash out regularly, and as often as needed; go inside and remove all loose scale, using a scaling hammer on the accessible parts. Should you find kerosene not doing any good, try this recipe: Fifty pounds salsoda, 35 pounds japonica. Put the ingredients in a 50-gallon barrel, fill half full of water, and run a steam hose into it until it dissolves and boils. Remove the hose, fill up with water, and allow to settle. Use one quart per day of ten hours for a 40 H. P. boiler, and, if possible, introduce it as you do cylinder oil to your engine. I have a small pump attached to a Worthington duplex, and operated by a link connected to valve arm; that feeds the compound direct to feed pipe, thus enabling one to feed systematically. The plunger is .75″ by 1.25″ stroke, and, as the duplex makes from 20 to 30 strokes per minute, the compound pump is able to pump even more than needed for 300 H. P. boilers. The above recipe is one of the very best compounds made.

You may buy this compound for fifty cents a gallon of a suave drummer, but, by buying the ingredients in quantities, one can make it for about eight cents per gallon.

Barr, in his excellent work on boilers, recommends tannate of soda as a remedy for scale composed of sulphate and carbonate of lime. As the japonica yields the tannic acid, I think the resultant equivalent to the tannate of soda. Whether this will hold strictly true or not, the fact remains that the compound will do the work. A year ago I had the pleasure to give this recipe to a brother engineer, and a recent report from him says, "The compound does all the work, except putting away the hose and putting in man-heads, while our boiler is entirely free from scale.'

T. T. PARKER.

An Error Corrected.

Editor American Machinist:

Looking over the Questions and Answers of the AMERICAN MACHINIST of June 12th, I see there is a little mistake in the answer to Question 230. You say that the square of .2 is .4, while it really is .04, and the length of the chord in that case will be: $\sqrt{2.25}-.04\times 2=1.486\times 2=2.972$ inches.

LOUIS KUNZ.

[We thank our correspondent for drawing attention to the error.]

Machine for Cutting Elliptical Holes.

Editor American Machinist:

In your issue of 22d May I notice a question referring to a machine for cutting elliptical holes in boiler plate. Some years ago a machine for the purpose was introduced in Glasgow, Scotland. It took the form of a drill press attachment.

I have not seen it at work, but remember having heard favorable comments on it.

If my memory is not at fault, the machine can be bought from Loudon Brothers, machinery merchants, Glasgow.

J. H. ABERCROMBIE.

A Faithful Flag-dog.

Scarcely any one who passes the point of intersection of the Gravois road and the St. Louis & Oak Hill Railway fails to notice a little dog acting as flagman at the railway crossing. This little animal is named Curly, and is the property and assistant of flagman Edward Howard. One day, as Howard was busy cleaning the lamps, a train dashed into sight around the curve. Several wagons were approaching the crossing, and would probably have driven on, meeting with a serious accident, had not the little animal rushed past its master and began barking furiously, which had the desired effect of stopping the teams. An idea then struck the master to train the dog to hold a flag. She could stand on her hind feet with perfect ease, and to hold a red signal flag in her mouth would be a great help to him, as the passing trains are numerous. It took but very little time "to break her in" to hold a little red flag, and now every time a train whistles she runs to fetch it, and, standing on her hind legs, holds it aloft to warn drivers of the danger. The engineers all know the little dog and look out for her. In addition to this flag work, Curly performs a variety of tricks and is a good mimic. Just now she is rearing a family, but every time an approaching train whistles she gets her flag and does her duty.—*The St. Louis Post-Dispatch.*

AMERICAN MACHINIST

Communications relating to the reading columns should be addressed to the Editor. All other communications should be addressed:

AMERICAN MACHINIST,
96 FULTON ST., NEW YORK.

PUBLISHED WEEKLY AT
96 Fulton Street, New York.

HORACE B. MILLER, Pres't and Bus. Manager.
LYCURGUS B. MOORE, Treas. and Sec'y.

F. F. HEMENWAY, Editor and Mech. Engineer.
J. G. A. MEYER, } Associates.
FRED J. MILLER, }

Special Announcements.

☞ *Positively we will neither publish anything in our reading columns for pay or in consideration of advertising patronage. Those who wish to recommend their wares to our readers can do so as fully as they choose in our advertising columns, but our editorial opinions are not for sale. We give no premiums to secure either subscribers or advertisers.*

☞ *Every correspondent, in order to insure attention, should give his full name and address, not for publication, but as a guarantee of good faith.*

☞ *We are not engaged in procuring patent rights, or in selling machinery, nor have we any pet scheme to advance, or hobby to ride.*

☞ *We invite correspondence from practical machinists, engineers, inventors, draftsmen, and all those specially interested in the occupations we represent, on subjects pertaining to machinery.*

☞ *Subscribers can have the mailing address of their paper changed as often as they desire. Send both old and new addresses. Those who fail to receive their papers promptly will please notify us at once. Date on wrapper denotes week with which subscription expires.*

Subscription.

$3.00 a year in advance, postage prepaid in the United States, Canada, and Mexico.
$4.00 a year to Other Countries, postage prepaid.

Advertising.

Transient, 35c. per line, each insertion.
"Business Specials," 50c. a line.

The American News Company,

Publishers' Agents, New York.
The International News Company,
BREAM'S BLDG'S, Chancery Lane, LONDON, E. C., ENG., will receive subscriptions for the AMERICAN MACHINIST, at 16/6 per annum, postage paid.

DEALERS SUPPLIED BY

The Albany News Company, Albany, N. Y.
The American News Company, New York, N. Y.
The Baltimore News Company, Baltimore, Md.
The Brooklyn News Company, Brooklyn, N. Y.
The Buffalo News Co., Buffalo, N. Y.
The Central News Company, Philadelphia, Pa.
The Cincinnati News Company, Cincinnati, Ohio.
The Cleveland News Company, Cleveland, Ohio.
The Colorado News Company, Denver, Colorado.
The Detroit News Company, Detroit, Mich.
The International News Company, New York, N. Y
The Minnesota News Company, St. Paul, Minn.
The Montreal News Company, Montreal, Canada.
The National News Company, New York, N. Y.
The Newark News Company, Newark, N. J.
The New England News Company, Boston, Mass.
The New Orleans News Company, New Orleans, La.
The New York News Company, New York, N. Y.
The Northern News Company, Troy, N. Y.
The Omaha News Company, Omaha, Neb.
The Pittsburgh News Company, Pittsburgh, Pa.
The Rhode Island News Company, Providence, R. I.
The San Francisco News Co., San Francisco, Cal.
The South West News Company, Kansas City, Mo.
The St. Louis News Company, St. Louis, Mo.
The Toronto News Co., Toronto, Ontario, Canada.
The Union News Company, New York, N. Y.
The Washington NewsCompany, Washington, D. C.
The Western News Company, Chicago, Ill.
The Williamsburgh News Co., Brooklyn, E. D., N.Y.

NEW YORK, JULY 3, 1890.

CONTENTS.

PAGE.

The Fiskkill Corliss Engine 1, 2
Thick and Thin Furnace Plates..... ..... 2, 3
Professor Sweet on Roads..... 3
A New Universal Joint..... 3
Tandem and Twin Compound Engines. By James B. Stanwood..... 3, 4
Compound Locomotives..... 4, 5, 12
Odontics; or the Theory and Practice of the Teeth of Gears. By Geo. B. Grant..... ..... 6, 7
Letters from Practical Men: A Follow Rest. By A Mechanic—Kerosene in Boilers. By F. T. Parker—An Error Corrected. By Louis Kunz—Machine for Cutting Elliptical Holes. By J. H. Abercrombie..... 7
A Faithful Flag-dog..... 7
The Use of Mechanical Safety Appliances..... 8
Literary Notes..... 8
Questions and Answers..... 8, 9
Manufactures..... 9, 10
Mr. Swinerton has His Say..... ..... 10, 11
Changing a Common Horizontal Engine to a Corliss Engine.. 11
Improved Universal Trimmer 11
Several Ways of Preventing Ice from Melting too Rapidly..... 11
Machinists' Supplies and Iron..... 12, 13

The Use of Mechanical Safety Appliances.

In deciding how many accidents or mishaps may have been prevented by the use of a device intended for their prevention, it is well to consider how much extra risk of mishaps is taken on account of the device being in use. In one sense it might be said that every time a safety valve opens and allows an overpressure of steam to fall, a boiler explosion is prevented, but the fact of the matter is that the safety valve has simply allowed the man in charge of the boiler to be careless without serious consequences, whereas if no safety valve were in use he would have been obliged to see to it that the pressure did not rise above the safe limit. Undoubtedly the number of boiler explosions would be very largely increased if there were no safety valves, but it is equally certain that if there were no safety valves the means of and appliances for knowing at all times just what pressure was in boilers, and for controlling the rate of evaporation would be much better than at present.

A short time since we referred to a narrow escape of the new steamship, the "Normannia," by reason of her having on the bridge a new device called a "motograph," by which her rudder and engines are placed under the immediate control of the officer on the bridge in case of emergency. While it is proper enough in one sense to say, as we did at the time that her escape from collision with an iceberg was to be credited to this device, the question naturally arises whether or not the vessel would have been going at a seventeen knot rate in a thick fog among icebergs if the device had not been there. If not, then the safety of the ship and her passengers is not to be credited to the motograph so much as is her speed during the voyage. If the risk of disaster in a fog at seventeen knots with the motograph is equal to the risk at a lower speed which we may suppose would have been considered necessary without it, then the device becomes, not what its inventor intended it for, but simply a means of increasing the average speed of the vessel, or, allowing navigators to be more careless.

The same principles apply to many of the safety devices used in railroading. The automatic brake, for instance, has undoubtedly prevented many collisions and other accidents, but it has also directly tended to higher speeds, shorter intervals between trains, and to the taking of risks generally by both managements and trainmen that would not be thought of without it.

Some safety devices absolutely prevent the possibility of accidents, as, for instance, shields for gear wheels; but such absolute preventives are very rare and most safety devices are as much, or more, devices for increasing efficiency; enabling men to assume more and greater duties, or, in other words, to take what would otherwise be much greater risks.

The real value of such things is not to be measured by the number of accidents known to have been prevented by them alone, but by what they do by their mere existence and without being called into action at all.

A pin is sometimes introduced into the gears of a lathe, which is calculated to shear off at a certain maximum strain and thus prevent the lathe being over-strained or broken. This pin is said to be put in to avoid breakage, but if it should occur that such a pin was not actually sheared during the life of a lathe and had, therefore, not prevented a single accident, its greatest service would nevertheless have been performed in allowing the lathe to be worked to its utmost capacity whenever the occasion demanded it, without fear of consequences. It is claimed that the greatest use of preparations for war is in preventing war, which may or may not be true, but the greatest use of most mechanical safety devices is probably not in actually preventing accidents.

The recent sharp advance in the price of ammonia will not be without its effect upon the ice-making industry, and may not improbably lead to a new source of ammonia being discovered, or to the discovery of a substitute for it in ice-making machines. The first announcement of the advance in price led to the report that a trust had control of the business, but the existence of such a trust seems to be unconfirmed, and the advance is probably due to the greatly increased demand for use in refrigerating and ice-making plants. The problem of the prevention of waste of ammoniacal gas will become more and more important to builders and users of refrigerating machinery as the prices rise, for it is to be remembered that its only use in refrigerating is analogous to the action of a sponge—it merely absorbs heat and when strongly compressed gives it up again to be carried off. All that needs to be replaced in a machine after it is once charged is that which is lost in ways which it is one of the objects of constructors to overcome.

There ought to be some one connected with the associated press at important centers, who has ideas enough about mechanics generally to telegraph coherent accounts of disasters. For example there was, not long since, an accident on the Baltimore & Ohio road, and the daily papers, evidently trying to make something out of the press dispatches, had, as a reason for the disaster, the breaking of both piston rods; the letting go of the "driving rod," whereby the rails were spread; the breaking of both main rods, one of which pounded its way through the cab, and other equally lucid explanations. Unless some elementary knowledge of the mechanism of a locomotive is possessed by the enterprising individual who sends in these dispatches, it would be better to leave out all details. And the daily papers that publish these dispatches, worked over to suit their ideas of the eternal fitness of things, would appear to much better advantage if some one on their staff was able to edit out a few of the impossibilities as given in the dispatches.

The average associated press dispatch, relating to accidents to or from machinery, reminds one of the traveler who was rather given to drawing the long bow. He had a friend who, by collusion, sat near him on important occasions, and, when he was piling it on rather steep, stepped on his toe as a hint to modify his statements. One evening this traveler was telling an assemblage of friends about a large church he had seen in his travels. This church, so he put it, was five thousand feet in length. Just then he felt the admonitory pressure on his foot, and added, without a break, and two feet wide.

The ultimate effects upon manufacturing and business interests generally of the recent movements of the Standard Oil Co. will probably be of considerable interest to the general public.

It has been stated in defense of this company that its monopoly could not be dangerous, because its business had to be carried on with regard to actual or possible competition, for the reason that it did not control the source of petroleum, but only its transportation, and the manufacture and transportation of oil.

But this argument will lose what little force it may have had from the fact that the company has for some time been acquiring oil territory in Ohio, and has recently "absorbed" four oil-producing companies, having a combined capital stock of over $8,000,000, giving it control of a large proportion of the oil territory of Pennsylvania and West Virginia. It is said by those in a position to know, that the Standard could, with its present power, put the price of oil up to five times the present figure if it should conclude to do so.

The Court of Appeals of New York State has rendered a decision that seems to get onto trusts with both feet. It was in reference to the sugar trust, and, without particularizing, the decision appears to be to the effect that all combinations that seek to control production or increase price in the State of New York are illegal; a righteous decision, most men will conclude.

The *Mail and Express* advises workingmen to refrain from work during the hot weather between the hours of 12 and 3. We don't hesitate to remark that this advice will be taken in its true ingenuousness by workingmen. Wonder if the *Mail and Express* workmen are given a three hours' vacation in the middle of the day.

Literary Notes.

THE ELEMENTS OF MACHINE DESIGN. Part I: General Principles. Fastenings and Transmissive Machinery. By W. Cawthorne Unwin, F. R. S. B. Sc., Mem. Inst. Civil Engineers, Professor of Engineering at the Central Institution of the City and Guilds of London Institute, formerly Professor of Hydraulic and Mechanical Engineering at the Royal Engineering College.

This is a new edition (eleventh), revised and enlarged, of The Elements of Machine Design. The former editions of this valuable work are so well known among engineers, that a general review of the work is unnecessary. In re-editing, considerable additions have been made to the original treatise, and therefore the author found it convenient to divide the work into two volumes. The present part contains the first twelve chapters of previous editions, except Chapter VI, which will be placed in Part II. The latter part will contain the remainder of the original treatise, dealing with machine details and especially with engine details. In the present work considerable additions have been made in almost every chapter, and the plan of the book has been so arranged as to enlarge the field it covers. Engineers, draftsmen, and all engaged in designing machinery will find the book to be a great assistance in determining the correct proportions of parts of machinery. The rules given are not all empirical rules, but they are based on scientific principles, and these principles are explained in a concise manner. The present part treats on materials used in machine construction; straining action to which machines are subjected; resistance of structures to different kinds of straining action; riveted joints, bolts, nuts, keys and cutters, journals, crank-pins, pivot and collar bearings; axles, shaftings and couplings; bearings for rotating pieces; friction and wedge gearing; sliding contact; tooth gearing; helical and screw gearing; belt gearing; rope gearing; chains and gearing chains The index is very complete, so that the work can be used as a ready book of reference. The book is published by Longmans, Green & Co., 15 East 16th street, New York. Its price is $2.00.

We have received from a correspondent a copy of a pamphlet of the Employes' Relief Association of Youngstown, Ohio, as in operation in the works of Brown, Bonnell & Co. This association, established last April, now numbers five hundred members. It had been the custom, our correspondent writes, to take up subscriptions in the works for men who were sick or disabled, and it was thought a society like the one named would be a more satisfactory arrangement. The entrance fee is one dollar, and the dues 12½ cents per week. There is provision for further assessing the members an additional 12½ cents per week. Five dollars per week is allowed for sickness or disability, and one hundred dollars goes to the family in case of death. Relief associations are excellent things when well managed; men who would otherwise carry no insurance are induced to make a little provision for dark days.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(257) W. W., Philadelphia, Pa., writes: Please send me a receipt for a paste to polish brass and copper. *A.*—Use sweet oil and tripoli, powdered bath-brick, rotten stone, or red brick-dust rubbed on with flannel and polished with leather.

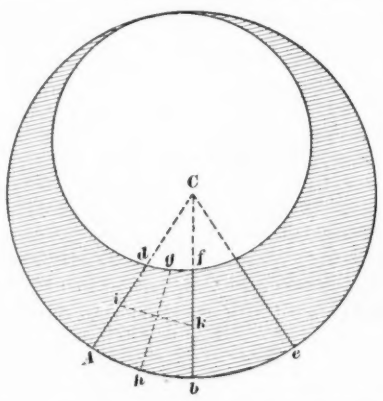
(258) S. O., Kansas City, Mo., writes: We are cutting a great deal of heavy steel rail for split switches, etc., and are using for

this purpose heavy planers. Will a milling machine, suitable size, do the work more economically where one rail has to be planed at a time? *A.*—We do not know of any milling machine that can compete with a planer on this kind of work; although it may be possible to construct a milling machine that will do the work more economically than a planer.

(259) X. Y., Poughkeepsie, N. Y., writes: Kindly let me know how to find the distance between the extremities of the two lines standing perpendicular to each other, and meeting each other at the other extremities. One line is ten feet long, and the other twenty feet. *A.*—The computation of this distance is the same as that for finding the hypothenuse of a right-angled triangle, namely, add the squares of the lengths of the two lines and extract the square root from the product. Thus: The square of 10 is $10 \times 10 = 100$, and the square of 20 is $20 \times 20 = 400$, and $100 + 400 = 500$; finally, the square root of 500 is 22.27+, which is the distance in feet from the extremity of one line to that of the other.

(260) G. S. C., New York, writes: I would like to know how to find the correct radius of a link. I have read every number of the AMERICAN MACHINIST since its first publication, and have found therein much to instruct me. *A.*—For shifting links the radius is made equal to the distance from the center of the crank-shaft to the center of the valve rod pin when the valve stands in the center of its travel; or when a rock shaft is placed between the valve and crank-shaft the radius is equal to the distance from center of crank-shaft to the center of the rocker arm pin when the latter stands in the center of its travel. The radius for a stationary link is equal to the length of the valve rod link.

(261) J. R., Cleveland, O., writes: Please give me a rule for marking off a fractional part of the area of the shaded surface between two circles as shown in the accompanying dia-



gram. For example, mark off between two radial lines one-quarter of the space beginning from any given point, as *A* on the figure. *A.*—You may adopt the following method. From the given point *A* lay off, on the circumference of the outer circle, a number of points as *b*, *e*, at equal distances apart, and through these points draw the radial lines *b C*, *e C*. Then find the area of each section *A b d f*, which may be found by multiplying its mean length *g h* by the mean width *i k*. In a similar way find the areas of all the other sections. Then take as many sections as will make up the required area. Of course this method will only give an approximate result, but this can be very close by making the spaces *A b*, *b e*, etc., very small.

(262) C. W., Madison, Ind., writes: What will be the percentage of friction in driving an engine shaft by the yoke motion such as is used in fire engines over the common pitman? Also will there be as much power transmitted with the yoke as with the pitman? *A.*—It is difficult to determine the exact amount of friction of each design; in fact, the friction will depend greatly on the workmanship and on the details which enter the construction. If both are well made and correctly designed the difference in friction will not be great, and this difference for practical purposes may be neglected. But the yoke is not so well adapted for transmitting power as a connecting rod, as the stress in the different parts of a yoke is much greater (particularly after the wear has created play) than the stress in the connecting rod; hence the yoke is not so reliable, and with its use a break-down is more apt to occur.

(263) Kerosene, Nantucket, Mass., writes: There is a kerosene store tank which is supposed to have a leak, but I cannot find the leak. I thought, however, that I could paint it inside with something that kerosene cannot penetrate. Can you give me a receipt? *A.*—We do not know of any paint that will withstand the action of kerosene for any length of time. Probably Dixon's Silica Graphite paint will answer the purpose better than any other paint. As far as the graphite in the paint is concerned, it will withstand the attack of the kerosene. The paint, however, is compounded with linseed oil, and for this kerosene is a solvent. The upshot, therefore, would be, that while the paint would not be perfect for the inside of the tank to hold kerosene, it would be better than anything else, because the graphite would form an impervious coat, and thus throw some of its protection and covering over the oil. We should advise you not to rest satisfied until you have located the trouble; kerosene is a dangerous thing to have running loose around a store, and if the leak cannot be stopped, get a new tank.

(264) W. C. C., Oakland, Cal., writes: Please give me a simple rule for computing the size of steam ports; or, in other words, what should be the proportion of the steam port to the cylinder. *A.*—Some builders make the area of each steam port equal to one-tenth the area of the piston for a piston speed of 600 feet per minute; others make the area of each steam port equal to one-tenth the area of the piston for a piston speed of 500 feet per minute; and for faster or slower speeds the area of the steam port is made proportionally greater or less. Adopting one-tenth of the area of the piston for a piston speed of 500, which is probably the most common proportion in stationary engine practice, we have the following rule: Multiply the given piston speed in feet per minute by .1, divide the product by 500, and multiply the quotient by the area of the piston in square inches; the last product will be the steam port area in square inches. To illustrate, take the following example. What should be the steam port area for a cylinder 20 inches diameter, piston speed 400 feet per minute?

$$\frac{400 \times .1}{500} \times 314.16 = 25.13 \text{ square inches.}$$

These proportions do not apply to low-pressure cylinders of compound engines.

(265) L. B., Grand Crossing, Ill., writes: I am building an upright engine, cylinder 3x4½ inches, steam ports ¼x1⅜ inch, exhaust port ⅝x1¾ inch, bridges ¼ inch. Do you think I would gain very much by giving outside lap, and if so how much would you give? *A.*—It will certainly be advantageous to give outside lap; we should make it ¼ inch, which will cause the steam to be cut off at ¾ stroke. 2. I wish to put on a link motion; and what I want to know is, if there is any rule for determining the distance between the eccentric pin holes in the link, and also the distance from the saddle pin to the center of link. The radius of the link is 18¾ inches. Please give me a rule for laying out the link correctly. *A.*—The distance between the eccentric rod pin holes in the link is, within a limited extent, arbitrary. On large engines it is customary to make this distance about 2¼ or 2½ times the throw of the eccentric. By the term "throw of the eccentric" we here mean twice the eccentricity of the eccentric. In very small engines, such as you are building, this distance can be increased, say to 3½ times the throw. Now if the valve has ¼ inch outside lap, and the steam port is ¼ inch wide, the throw of the eccentric will need to be equal to twice the sum of the lap and width of steam port, that is, equal to $(\frac{1}{4} + \frac{1}{4})\ 2 = 1$ inch, and making the distance between the eccentric rod pins equal to 3½ times the throw, we have 3½ inches for this distance. We assume that the link is to be used for reversing the motion of the engine only; under these conditions we should put the saddle pin on the center line of the link. If the link is to be used for changing the point of cut-off as well as for reversing, the saddle pin will have to be placed somewhat closer to the eccentrics. In our issue of Dec. 4th, 1886, we have given an example in laying out a link motion, to which we must refer you. In this example you will find the methods for determining the position of saddle pin and other important points. For finding the proportions of links see our issues of Feb. 12th and 26th, 1887.

(266) J. L. H., Washington, N. J., writes: I have four boilers, each 5 feet diameter and 15 feet long, carrying a steam pressure of 80 pounds. I have been thinking of changing the blow-off pipe, which at present is attached to bottom of the back head, and with the blow-off in this position I cannot blow out all the sediments which collect on the bottom of the boiler. I therefore wish to connect the blow-off-pipe to the bottom of the boiler, which already has a reinforcing plate in proper position and is tapped 2 inches. Do you think it is a good plan to change? If so, what kind of pipe and elbows should I use for a first-class job? Or will it be better to use short bends in place of elbows? Would you use globe valves or plug cocks? *A.*—We believe the change to be a good one. We should use wrought-iron pipes and malleable iron elbows. Care should be taken to protect the pipes and elbows from excessive heat, and from coming in contact with ashes. Globe valves work with greater freedom than plug cocks, but globe valves are not so trustworthy, because, should any of the sediments or scale collect on the valve seat, the liability is that the valve will not be closed when appearances may lead to the belief that it is closed; water will then escape out of the boiler, and if this continues for some time without being observed, may lead to damage. But there can be no deception as to whether a plug cock is opened or closed; we should therefore use plug cocks. Of course when these are not frequently used they are liable to corrode and stick fast, but the remedy for this evil is obvious—use them often. The casing and the plug should be made of the same metal; gun metal is to be preferred to brass, because, when made of the former metal, the surfaces are harder and will wear longer, and the whole being made of the same metal the expansion will be nearer equal. The cocks should be of good design, in which provision is made to prevent the plug from flying out of the casing.

(267) Bert, Troop, Pa., writes: Please inform me what questions are asked in the examination for stationary engineers, and where the board of examiners meet. In the above I allude to New York. *A.*—There are no regular sets of questions asked; the questions will be such as to draw out your knowledge of running and taking care of stationary engines and boilers, and to determine your natural capacity, mechanical skill, and general fitness for the position. Chapter 643 of the laws of 1886 provides that: It shall not be lawful for any person or persons to operate or use any steam boilers to generate steam, except for railway locomotive engines, and for heating purposes in private dwellings, and boilers carrying not over ten pounds of steam, and not over ten horse-power, to act as an engineer for such purposes in the city of New York, without having a certificate of qualification therefor from practical engineers detailed as such by the Board of Police; such certificate to be countersigned by the officer in command of the Sanitary Company of the Police Department of the City of New York, and to continue in force one year, unless sooner revoked or suspended. Such certificate may be revoked or suspended at any time by the Board of Police upon the report of any two practical engineers detailed as provided in this section, stating the grounds upon which such certificate should be revoked or suspended. When such a certificate shall have been revoked as provided in this section, a like certificate shall not in any case be issued to the same person within six months from the date of the revocation of the former certificate held by such person. To the above the following rule is added: When, on examination of an applicant, it appears to the satisfaction of the engineers that he lacks natural capacity or mechanical skill, knowledge or experience, or is unfitted by habits of insobriety to perform the required duties in a manner consistent with safety to life, a certificate of qualification will be denied. Renewals of certificate will be refused, and certificates will be revoked on proof of like deficiencies. Holders of certificates must apply to the officer in command of the Sanitary Company for re-examination and renewal of certificates on the date of the expiration of the certificate. No renewal will be granted without re-examination of the applicant. The office is in the Police Department of the city of New York, 300 Mulberry street.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Thursday for the ensuing week's issue.

Lexington Cut Iron Gears. See adv. on p. 20.

Link-Belting and Sprocket Wheels.

Send for Catalogue of Link-Belting.

Over 50,000,000 feet of Link-Belt in use.

Link-Belt Engineering Co., Philadelphia and N.Y.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

Mech'l Drawings; best; cheap. Box 457, Reading, Pa.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

The best Upright Hammers run by belt are made by Jenkins & Lingle, Bellefonte, Pa.

Drop Presses, Punches and Shears. Williams, White & Co., Moline, Ill., manufacturers.

Pattern and Brand Letters. Vanderburgh, Wells & Co., 8 Spruce St., New York.

Davis Key-seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

Selden Packing for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y.

Ice and Refrigerating Machines, 155 sold, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

Castings for small and medium-sized vertical engines. Humphrey's Foundry, Bellefontaine, Ohio.

Valve Seat Rotary Planing Machine. Pedrick & Ayer, Philadelphia, Pa.

Cylinder Boring and Facing Machines. Pedrick & Ayer, Philadelphia, Pa.

Light Special Machinery and Tools to order. The Meriden Machine Tool Co., Meriden, Conn.

Standard Tool Co.'s Twist Drills. S. A. Smith, 23 S. Canal st., Chicago, Western Representative.

Well-drilling Machinery and Tools. Williams Brothers, Ithaca, N. Y.

Audubon Machine Works, New Haven, Conn. Special machinery, heavy and light.

Steel Name Stamps, etc. Address W. G. Sackmann, 1099 First ave., Cleveland, O.

Get particulars of our new Wall, Suspended and Radial Drills. C. H. Baush & Sons, Holyoke, Mass.

One Star Hack Saw will do as much work as five of any other kind.—N. B.

F. C. & A. E. Rowland, New Haven, Conn. Hydraulic, Mill and Special Machinery to order.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Most sensitive and durable Damper Regulator made; works within one pound; send for circular. T. Kieley, 11 W. 13th st., New York.

Brown & Sharpe Mfg. Co's. standard spur and bevel gears carried in stock by Chandler & Farquhar, agents, 177 & 179 Washington st., Boston, Mass.

For the Latest Improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

S. W. Card & Co., Mansfield, Mass., make everything in the line of Taps and Dies. S. A. Smith, 23 S. Canal st., Chicago, Western Agent.

Patent Attorney. R. G. DuBois, 715 11th st., Washington, D. C., procures first-class patents on inventions. Valuable Hand-book on patents free.

Horton's Chucks. We offer the balance of our stock at 50 per cent. discount. McFadden Co., Philadelphia, Pa.

Curtis Pressure Regulators. Curtis Return Trap. Curtis Damper Regulator. See June 5, p. 18. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

25" 28" 32" 36" Upright Drills a specialty. Finely made, great capacity, quickly operated, prices low. Send for list of firms using our Drills. J. E. Snyder, Worcester, Mass.

25" 32" 37" 42" "Only Drill Press built on 'Ko-rekt' principles, even if they come from Jersey." Gould & Eberhardt, New Ark, N. J.

C. H. Redman & Co., Newark, N. J., Manufacturers of Light Machinery, Automatic Selling Machines. Telephone and Telegraph Instruments, Sewing Machine Attachments, Models, etc. Contracts solicited.

For Sale—Bound volumes of the Patent Office Gazette for years 1883, 1884, 1885, 1886, 1887 and 1888. Price, $4 per year. Address J. C., care of AMERICAN MACHINIST.

Every draftsman needs one. The Engineer's Sketch Book of mechanical movements, appliances, devices, contrivances, etc., by T. W. Barber. 1,936 illustrations, 8vo. cloth, $3. Catalogue of books on mech. subjects free. E. & F. N. Spon, 12 Cortlandt st., New York.

Machine Tools for Sale—One 8-ft. pulley lathe, $500; one 18-inch New Haven lathe; one 36-inch drill press. Lot vises, anvils, general outfit of machine shop; cheap; no further use for them. Logan Machine Works, Oil City, Pa.

De Lamater Screw Propeller Wheel made only by The Samuel L. Moore & Sons Co., Elizabethport, N. J., who have purchased from C. H. De Lamater & Co., New York, all their patterns, books of record, gauges, etc. Location and equipment well adapted for Heavy Steamship Repairs.

Stub Ends and Connecting Rods for small connections. Especially adapted for Valve Rod for Steam Engines. T. C. Dill Machine Co., Philadelphia, Pa.

Screw Propellers. Manufactured by H. B. Roelker, 22 Cortlandt st., New York, Superintendent of the late De Lamater Iron Works, of same patterns and designs as before, adapted to each vessel. Consulting Expert and Constructing Engineer. Estimates on machinery, damages, etc. Air ice machines.

Just concluded. "Modern Locomotive Construction." By J. G. A. Meyer. The above series of 106 articles, which have attracted so much attention everywhere, is now concluded in newspaper form. Copies of the American Machinist containing the entire set sent by mail to any address in the U. S., Canada or Mexico for $5.30, or single copies 5 cents each. American Machinist Publishing Co., 96 Fulton st., New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram; also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 53 East 10th st., New York.

"Binders" for the American Machinist. Two styles, the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 53c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. American Machinist Publishing Co., 96 Fulton st., New York.

Just concluded. "Practical Drawing." By J. G. A. Meyer. Copies of the American Machinist containing the above series of 93 articles sent by mail to any address in the U. S., Canada or Mexico, for $4.65, or single copies 5 cents each. American Machinist Publishing Co., 96 Fulton st., New York.

MANUFACTURES

A $1,000,000 cotton factory is to be erected at Montgomery, Ala.

The Morgan Manufacturing Co., of Spartanburg, S. C., will increase its capital stock, and will establish an iron foundry.

H. K. Coleson, L. F. West, E. V. McCaskill and others are organizing a stock company to establish a cotton and woolen factory at Milton, Fla.

G. A. Carter & Co., tack manufacturers, Brockton, Mass, have placed a 15 horse-power Sprague motor in their factory, to run the machinery.

Putnam & Son, shoe manufacturers, of Berlin, Wis., intend building a large factory at Rockford, Ill., to be ready for occupancy by September.

The West Superior (Wis.) Iron and Steel Co. proposes to build a Bessemer works and rolling-mill for steel plates, beams and structural shapes

Thomas Evans has, it is reported, purchased the old water-works plant, at Chattanooga, Tenn., and will convert it into a foundry and machine shop.

Work is to be commenced shortly on the new building for Golden's Foundry and Machine Works, at Columbus, Ga. It is to be two stories 60 x 210 feet, and will cost $25,000.

The Illinois Steel Co., of Chicago, will erect an iron building, 360 x 150, for a finishing mill at its South works, where a number of extensive improvements are being made.

The Marion (S. C.) Iron Works Company has been organized and officers elected. The whole of the

$20,000 capital has been subscribed, and work will begin on the new building at once.

The works of the Monongahela Manufacturing Co., of Monongahela, Pa., consisting of a foundry machine shop, blacksmith shop and pattern department, have been destroyed by fire.

The Orange Lake Manufacturing Co., recently incorporated by F. A. Gardner, D. H. Irvine, G. W. Wilson and others, to erect a foundry and machine shop, have decided to locate in Ocala, Fla.

The New England Piano Company of Boston, Mass., employing 600 hands, has notified its employes that nine hours will constitute a day's work, and the pay will be the same as for the ten hours' day.

The employes in the several paper mills at Dalton, Mass., operated by the Cranes, together with the Dalton shoe shop men, were recently notified that they would be required to work only eight hours Saturdays until October 1.

The foundation, 1,750x450 feet, for the new machine shops to be built by the Chesapeake & Ohio Development Company at Clifton Forge, Va., for the Chesapeake & Ohio Railroad, has been laid off, and work will be commenced at once.

The Auburn Stove Foundry Company has been organized at Auburn, Me., by the choice of H. W. Hutchins, president, and J. R. Learned, treasurer. Capital, $50,000. The plant of the Biddeford Stove Company will be removed to Auburn.

The Manhattan Foundry Company, of Manhattan, Kan., has been incorporated, with a capital of $36,000. Directors are Soloman Secrist, of Rudolph, A. J. Whitford, J. C. Neal and J. W. Kettleman of Manhattan, and Nels Christensen, of Clarkson.

J. W. Maxwell, recently engineer and superintendent of the Whitely Steel Company, has formed a partnership with G. H. Vincett, of Syracuse, N. Y., under the firm name of the Springfield Steel Casting Company, and will engage in the manufacture of steel castings in Springfield, O.

The New Duluth Land Company, New Duluth, Minn., has signed a contract with one of the largest paper manufacturing companies in the United States to erect a large plant at New Duluth, to cost from $200,000 to $350,000, and employ a large number of men. It will make print and wrapping papers.

One of the proposed industries to be located at Rock Point, Pa., the site of the proposed town of Ellwood, is a plate glass manufactory that will exceed in capacity all existing plants of the kind. I. L. Ellwood, of De Kalb, Ill., H. W. Oliver, George I. Whitney, James McCrea, H. W. Hartman and others are interested.

At Jacksonville, Ala., negotiations have been completed for the establishment of a $7,000,000 steel plant, the second of its kind in the world. Mr. McCarty, the inventor, asserts that by his process steel can be successfully manufactured from any kind of ore, the presence of phosphorus proving no hindrance whatever.

A rolling-mill for the manufacture of merchant bar-iron from scrap is being built at Forth Worth, Tarrant County, Texas. It is to be called the Texas Rolling Mill and Iron Works, and will have a daily capacity of about 40 tons. The officers are: G. E. Beach, president and general manager; J. G. Williams, vice-president; H. Schwartz, secretary; E. H. Keller, treasurer, and P. H. Durack, superintendent.

The Wetmore Shoe Co., of Raleigh, N. C., which has employed sixty convicts at the penitentiary at Raleigh, has just suspended operations and surrendered its convicts, who were employed under contract. Money had been steadily lost by the use of this labor, as many firms will not handle penitentiary made shoes. The plant will be removed to a private factory at Greensboro, and convict labor dispensed with.

The iron foundry at Houlton, Me., destroyed by fire a short time ago, is being rapidly rebuilt. The old ruins have been cleared away and the foundry building is now receiving its roof. This is 40x50 feet in extent. The new machine shop will be 40x75 feet. The building will be one story in height, strongly framed and well lighted. The wood-working department will occcupy the north end of the shop.

The rolling-mill to be erected at Muskegon, Mich., will be owned and operated by the Muskegon Iron and Steel Company, of which S. T. Williams is president, W. H. Thompson vice-president, and W. F. Ayers secretary and treasurer. The mill on starting will contain one 18-inch and one 9-inch three-high train of rolls. The mill will produce merchant bar-iron and steel and copper rods. The erection of an open-hearth steel plant and a bridge shop by the company is contemplated for the near future.

The improvements proposed for the Davol Mills at Fall River, Mass., will be quite extensive. The two new boilers will be of 1,200 horse-power each, and the compound engine will take the place of the two now in use. This new steam plant, it is said, will effect a saving of $7,000 on fuel and running expenses, or seven per cent. on the entire proposed increase. A small addition to the boiler-house will be necessary. The new system of carding with new improved cards will afford a great saving in floor space, which will be occupied by 18,000 additional spindles. During the past two years about $100,000 worth of carding, spinning and weaving machinery has been put in.

The changes that are being made at the Copsecook paper mill of the S. D. Warren Company, Gardiner, Maine, will almost make a new mill throughout. A new addition, 35x56 feet, two stories high, will be erected at the north end of the present mill. The upper story will be used for rag sorting and the lower as a bin-room. At the west side of the machine-room an addition 25x112 feet will be built, which will be used as a machine-room, a new 90-inch machine being put in. A new rag rotary, a 60-inch paper machine, new stacks of supercalenders, two new paper cutters and new heating engines will be added to the machinery of the plant, the entire equipment being run by horizontal wheels. The new changes will call for extra help, and double the present output of 4½ tons of book paper daily.

It is reported that plans for the erection of iron and steel works at Kirkland, Wash., on the eastern shore of Lake Washington, opposite Seattle, are now consummated. Negotiations have been quietly progressing for several months and are said to have reached a favorable conclusion, so that the erection of the works will begin immediately. The company will expend $1,000,000 within the next 12 months. Among those who are actively interested in the iron company are: Gen. Russell A. Alger, of Detroit, Mich.; Joshua M. Sears, of Boston, Mass.; H. A. Noble, of Des Moines; J. L. Norton, of Chicago: Peter Kirk and W. W. Williams, formerly of England, but now of Kirkland, and Edward Blewett, Jacob Furth and Bailey Gatzert, of Seattle, Wash.

The Boston Wharf Company has recently made arrangements with the firm of Pierce & Son, 127 Summer street, large manufacturers of shoes and slippers, to erect for them on the corner of Congress and Farnsworth streets a six-storied brick and stone factory, to cover 5,000 feet of land, and to contain about 30,000 feet of floor space. The building will be specially adapted for the purposes intended, will be substantially built, and be very light. It will be provided with a 25-horse-power gas engine, elevators, and all modern appliances for safety and economy. The property of the Boston Wharf Company is becoming a large center for manufacturing. Already upon its property, and upon land sold by it, are the extensive factories of the Boston Button Company, Chase & Co. Corporation, Standard Sugar Refinery, Whittier Machine Company, Moore & Wyman Elevator and Machine Works, Bay State Belting Company, Consolidated Electric Company, Putnam & Co., C. L. Hauthaway & Co., and many others. The company is progressive, and has made during the past five years great strides in developing its property in a substantial manner. Over $1,000,000 has been invested in factory and other buildings on this property within that time.—*Boston Daily Traveler.*

The boiler makers and iron shipbuilders of the United States held their tenth annual meeting in our city on the 17th, 18th and 19th inst. The two principal purposes of the convention was to increase the membership of the association and have the eight-hour system universally adopted by the boiler makers and iron shipbuilders throughout the country. It was decided to inaugurate the eight-hour system, provided the consent of the American Federation of Labor can be obtained. The membership is now 1,100 strong, with a prospect of a great increase in the near future. At the meeting last Thursday afternoon, the full financial reports of the various branches of the union were received, and in the evening an excursion was tendered the convention by the local union, on the Grand Republic. The following are the new officers to serve for the ensuing year: President, Thomas J. Curran, New York; vice-president, George Thompson, Minneapolis; secretary, Charles Marugg, St. Louis; treasurer, Anthony Dubby, Brooklyn. Executive council, Thomas W. Dwyer, Chicago, chairman; William H. Longacre, Reading, Pa.; Wm. Lynch, St. Paul; Arthur Graham, Philadelphia; Frank Stevens, New York. The advisability of petitioning Congress to grant subsidies to promote the iron shipbuilding industry of the country was discussed.—*Age of Steel* (St. Louis, Mo.)

For a year or more, electrical engineers have been trying to induce New England manufacturers to introduce electricity into their factories as a motive power to run their machinery by subdividing the power up into units. It was set forth that such a method would result in a considerable saving to the concern, as less friction would have to be overcome, therefore less power would be required. Generally the power is centralized even in case where electricity is used, one motor doing all the work. By dividing the power the expense will average less, as current can be used as needed. One or more of the motors can be shut down at will, whereas when the electric power is centralized the one motor used must be run for any amount of work to be done. The great hindrance to the division of power is the original cost. Small motors with the same total horse-power as one large motor will cost the most, but it is claimed the saving in running will pay for the difference in a short time. At present many manufacturers are watching the working of the plant in the M. A. Packard & Co. shoe factory at Brockton, Mass. The electric power there is divided into three units, a 15 horse-power motor furnishing power for the bottoming department, a 10 horse-power motor for the sole leather department and elevator, and a 5 horse-power motor for the stitching department. Formerly for a year and one-half, one motor of 25 horse-power capacity run the machinery of the whole concern. By the change it is claimed the saving will be 6 horse-power. The local electric light and power company, in view of this, have agreed to furnish power for less than when one motor was used. In this plant Sprague apparatus is used throughout.—*Commercial Bulletin.*

Mr. Swinerton has His Say.

Editor American Machinist:

Again I am under obligation to you for publishing my letter, and for your editorial upon the same, which appeared in your issue of the 15th of May. Your intended compliment to myself, "Mr. Swinerton is a man of intelligence, etc.," swiftly fades away to much less than a shadow, when you say in the next paragraph, "If we were to refer him to the laws of Morin . . . "laws well known to every school-boy" . . . "or to the simplest laws of mechanics, it would not avail." Well intended, I dare say, but complimentary or logical it is not.

The invention is an absurdity, say you. All inventions are absurdities at first. The word "absurd," says Balzac, the great and progressive Frenchman, condemned the invention of gunpowder, of printing, of spectacles, of engraving, and the more recent discoveries of photography and steam, and if he had lived in our day, he would have no doubt added the telegraph and telephone.

In your issue of May 1st you stated, in substance, that my invention contravened "well-settled laws of mechanics and of friction." In my somewhat extensive researches during the past four or five years, I have been unable to find such laws, hence, I ventured to ask you for a citation of them.

This I suppose I have in the following quotation from your editorial of May 15th: "The laws of Morin in regard to friction, which have never been overturned," say you. Now, I propose to show by many of the ablest writers upon mathematics and mechanics, that these laws have, long since, either been disregarded or pronounced limited and untrue. First, then, Mr. John E. Clarke, Ph. D., of Boston, a mathematician and an author of mathematical works, who has given much thought and study to the polygonal wheel, says: "The MACHINIST's first objection to the wheel is, that it contravenes 'well-settled laws of mechanics and of friction.'" In reply to your inquiry where those laws were to be found, it gives the startling reply that, "Every school-boy knows them," and then refers to Morin's laws, and the law of compensation, the latter of which can have no possible reference to the subject in hand. It may be possible that all school-boys are acquainted with Gen. Morin's laws, but a man who, to-day, calls *these laws*, is still a school-boy.

A mechanical law is subject to no exceptions, else it is no law. Now no doubt there are many well-settled laws of mechanics, but they do not exist in the department of friction.

It is not even agreed what friction is, or where the so-called friction ceases, and adhesion and cohesion begin.

Second. Mr. A. M. Wellington, Railway Location, p. 503, says of Morin's laws:

"There is, even at the present day (1885) hardly a single text-book of engineering (at least in English) in which these laws are not laid down as facts; yet they are now generally admitted to be entirely incorrect. . . . It is clearly proven that there are no limits nor conditions under which his laws are approximately true." The same, in substance, may be found in the works of the following able writers on mechanics: Buell, Hirn, Bochet, Kimball, Roueth, Smith, Sonnet, Rankine, Thurston and Trautwine. During more than three years we have experimented with engines equipped with polygonal wheels on the B. & L., and Boston & M. R. R. These engines varied in weight from 33 tons to more than 50 tons.

STATEMENTS BY OFFICERS AND ENGINEERS OF THE B. & M. R. R.

BOSTON & M. R. R.,
Department of Machinery,
Oct. 29, 1889.

MR. C. E. SWINERTON, *Pres. Swinerton L. D. W. Co.*

MY DEAR SIR: Referring to your inquiry of recent date, the locomotive Onward commenced her regular trips on our Portland express, Jan. 7, 1889, and was taken off July 6, 1889, after running just six months. Her performance on this train gave good satisfaction, and she made her time.

The train is a four-hour train, distance 115 miles with 15 stops; number of cars from 6 to 8.

WM. SMITH,
Sup't. M. P. & M.

I concur in the above, and hope to see the locomotive Onward tried on other roads. The increased traction developed by this locomotive is her strong point.

JAS. T. FURBER,
Genl. Manager B. & M. R. R

The following B. & M. engineers, W. E. Dunlap, George W. Falls, F. F. Coggin, F. S. Saunders, George A. Wyman, and L. C. Todd, state from their experience with polygonal wheels, that largely increased traction is obtained by their use.

EXPERIMENTS BY M. N. FORNEY, OF N. Y., WITH ENGINE ONWARD.

In July, 1889, our company employed Mr. Forney, by the advice of Mr. Wm. Smith, Sup't M. P. & M. B. & M. R. R., and Mr. George W. Tilton, Sup't M. P. & M., Chic. & N. W. Ry., to make tests with the Onward on the B. & M. R. R.

Mr. Forney's plan was, as he stated, to do certain work with polygonal wheels, then turn the wheels smooth and repeat the work.

First he went to Portland, and returned with the Portland express.

The tables below show a part of the work done under Mr. Forney's direction. The run between Somerville and Reading, distance 10¼ miles, with the empty passenger cars, making 14 stops going and 12 returning. Engineers were instructed to make the quickest time possible.

WITH POLYGONAL DRIVING WHEELS.

	July 9th, 1889.		July 24d, 1889.		
	Geo. W. Falls.	L. C. Todd.	L. C. Todd	John Kneeland.	F. F. Coggin.
Engineers	Minutes.	Minutes.	Minutes.	Minutes.	Minutes.
Somerville to Reading	57½	65¼	62		66
Reading to Somerville	36	39¼	43		42¾
Round trip	93½	103½	105		108¾

PULLING TESTS AT LAWRENCE, MASS., WITH ENGINE "ONWARD."

	July 23, 1889.		Differences in Amounts Drawn.	Differences in Per Cent.
	With Smooth Wheels.	With Polygonal Wheels.		
Grade, 37 ft. to the Mile. Distance, 1,750 ft.	Pounds.	Pounds.		
Without air and without sand	830,500	589,050		168.19
*With air and without sand	545,570	422,090		77.35
Without air and with sand	890,870	497,870		59.93
With air and with sand	1,078,960	523,086		48.48

WITHOUT AIR AND WITHOUT SAND.

	July 16, 1889.		Differences in Amounts Drawn.	Differences in Per Cent.
	With Polygonal Wheels.	With Smooth Wheels.		
Grade, 37 ft. to the Mile. Distance, 1,750 ft.	Pounds.	Pounds.		
Without air and without sand	859,550	830,500		103.50
*With air and without sand	967,600	545,570		177.36
Without air and with sand	1,328,346	890,870		149.08
With air and with sand	1,602,016	1,078,960		148.46

* With air—signifies that increased weight was thrown upon the drivers by means of the air lever.

With the pulling tests Mr. Forney closed his experiments, remarking that they were the most exhaustive he had ever made. For obvious reasons he did not attempt to draw the Portland express with smooth wheels, although he said Mr. Smith thought it unadvisable.

We thought Mr. Smith exercised sound judgment.

Six months ago a set of polygonal wheels were placed under an engine on the elevated road, N. Y. City, which, though not en-

tirely satisfactory, on account of the facets being cut one inch wide, causing a vibration and an objectionable noise, yet after they were partially destroyed by brake shoes the engineer states that they do much better work than round wheels, especially up grades.

Col. Hain, the general manager, has ordered the wheels of an engine now building to be made polygonal. The facets will be cut $\frac{7}{12}$" wide.

A report from Mr. J. H. Olhausen, Gen'l Sup't Central R. R. of N. J., just received, shows that the Onward drew the Philadelphia express on that road between Jersey City and Bound Brook, and made the time. This is said to be one of the fastest trains in the world. In view of the above facts, we think we have good reason to believe that sooner or later the polygonal wheel will be added to Balzac's list of "absurdities."

Yours ever truly,

C. E. SWINERTON,

Pres. of the Swinerton L. D. W. Co.

[Mr. Swinerton having now had the last say on the subject, we shall close it until there are new developments.]

Changing a Common Horizontal Engine to a Corliss Engine.

A few months ago it became necessary to re-bore the cylinder of a plain 24x48-inch horizontal slide valve engine at Lorillard's tobacco factory, Jersey City. This engine had been in service for years; its cylinder had been several times re-bored, and thereby the thickness of the metal at the bottom of the cylinder was reduced to three-eighths of an inch. Mr. T. F. Morrin, the chief engineer at the works, decided that it was not advisable to again reduce this thickness, and therefore recommended a new cylinder to be put in place of the old one. Mr. Morrin also considered that with a Corliss engine he would be enabled to reduce the coal bills.

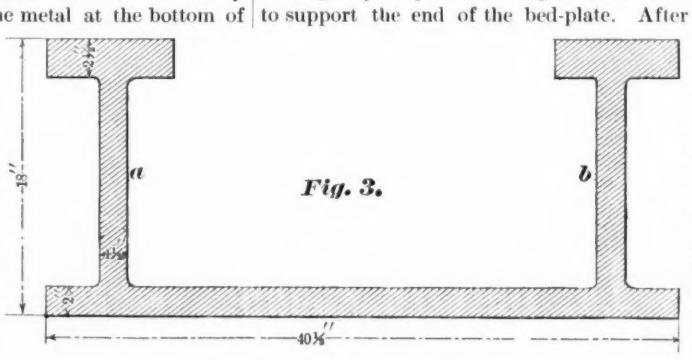
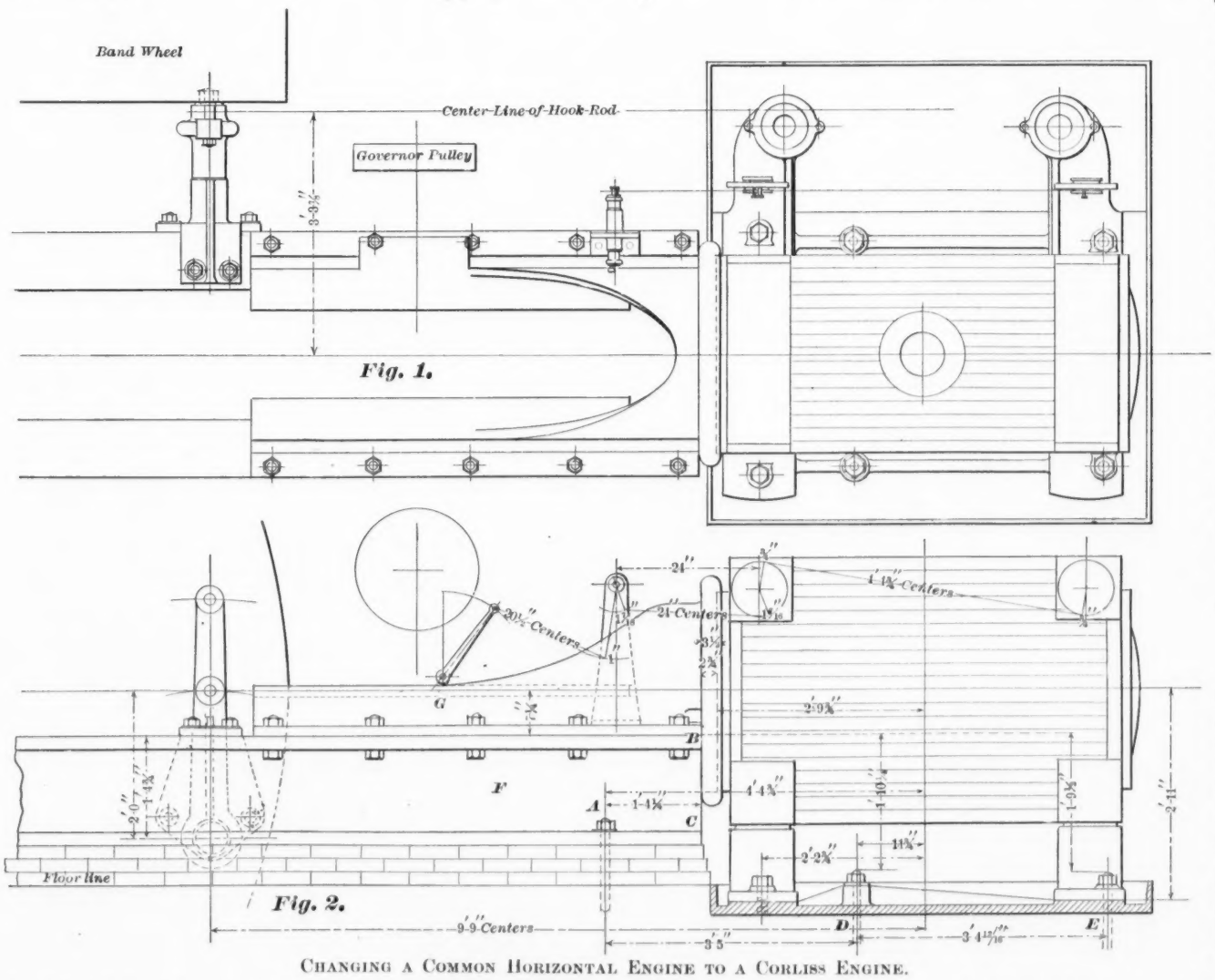


Fig. 3.

To put in a new Corliss engine was out of question, as the allotted time of four days for making the change was too short. It was therefore decided to put in a Corliss cylinder only in place of the one in use, and retain as many of the remaining parts of the old engine as possible. Figs. 1 and 2 show a plan and elevation of the new cylinder as it appeared after the job was finished. The large band-wheel, crank-shaft, connecting rod and crosshead of the old engine were used. The portion of the bed plate *F* shown in the illustrations is also part of the old engine; the largest portion of the previous foundation remained undisturbed, and the position of the foundation bolts was not changed. In order to put in the new cylinder within the time allowed, Mr. Morrin laid out his plans carefully, and made several preliminary preparations before the engine was stopped. For instance, the end of the foundation bolt *A* was carefully trimmed off, and its center marked upon it. From this center all the distances to important points on the old cylinder were carefully noted, from which an accurate drawing for the new cylinder was made. This cylinder, with all its attachments, was built by Watts-Campbell Co. of Newark, N. J. The line *B C*, along which the bed-plate had to be cut, was also laid off from the center of the bolt *A;* and the portion of the foundation directly under the cylinder, which had to be removed so as to clear the exhaust, and other details of the new cylinder, was carefully marked off; and nearly all of this change in the foundation was made while the engine was running, leaving only a pier about eight inches wide to support the end of the bed-plate. After these preliminary preparations were finished the cylinder was taken off, and a number of holes drilled in the bed-plate along the line at which it had to be cut; a section of the bed-plate is shown in Fig. 3. Besides the holes drilled through the thickness of the metal, a vertical hole was drilled about half way through the depth of each web *a* and *b*. The pier at the end of the bed-plate was then removed, and with two blows on the drifts placed in the vertical holes in the webs, the portion of the bed-plate not needed was broken off. It took just two days (10 hours per day) to strip the old engine and cut off the bed-plate. The new cylinder could have been put in place in another two days, but here Mr. Morrin found that he could have a few days longer to finish the work than was first anticipated, and therefore the men were not required to work more than ten hours per day. The whole change was made in six days, that is, from the time the old engine was stopped up to the time the engine with the alterations was started, six days elapsed. This we believe to be an excellent record, and reflects credit on the management of Mr. Morrin.

The new cylinder is 24 inches diameter, and the stroke is 48 inches, which dimensions are practically the same as the original dimensions of the old cylinder. The slides are cast in the box girder *G*, which is firmly bolted to the old bed-plate *F;* the cylinder is, of course, bolted to the girder, and is further supported by the foundation, as shown. The bolts *D* and *E* are the old foundation bolts somewhat shortened.

The crank-shaft, countershafting and belts were not disturbed, consequently the speed of the engine was limited, and is at present about 49 revolutions per minute. The engine develops 240 indicated horse-power, uses 22 pounds of water per horse-power per hour instead of 38 pounds as before, and saves 1¾ tons of coal per day. The intentions are to increase the speed of the engine as soon as an opportunity is found to do so, and still better results are then expected. The engine at present certainly works very smoothly and satisfactorily in every way, and has in no wise an appearance of a patched-up job. All the proportions of the different parts are good, and harmonize so that a casual observer would scarcely notice that any change had been made. The whole job is a credit to all concerned.



CHANGING A COMMON HORIZONTAL ENGINE TO A CORLISS ENGINE.

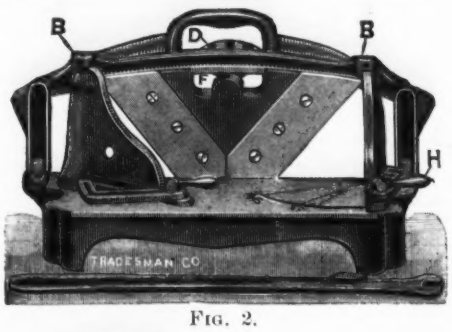
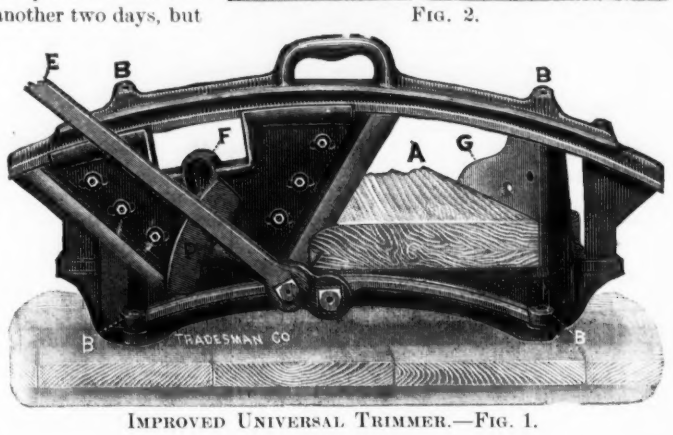


FIG. 2.



IMPROVED UNIVERSAL TRIMMER.—FIG. 1.

Improved Universal Trimmer.

In our issue of July 18, '89, we illustrated a trimmer intended for the use of pattern makers and other workers in wood. The design of this machine has recently been somewhat improved, and we now give illustrations showing it as at present constructed.

The circular guides upon which the knives move, and which make the cut a shearing one, distributing it over a comparatively great length of the edge, have been retained, as well as other features which have proven valuable, the most important change being in the manner of connecting the lever by which the knife is moved. In the center of the knife carriage is a vertical slot, in which works a roller that is attached to the sector *D*, Fig. 1. This sector is pivoted below at the center of the frame, and the lever is adjustably connected to it by means of square notches formed on the back of the sector, into which a projection on the lever fits. By changing the lever from one to another of these notches it can be placed in the most convenient position for the job in hand.

Fig. 1 is a rear view of the No. 13 machine, which weighs 150 pounds, while Fig. 2 is a front view of the No. 8 machine, weighing 50 pounds. The engravings being made to the same scale give good idea of the relative size of the two machines. Many of these machines are in use in pattern shops, where they are proving to be of great value, some shops providing a machine for each man, which is fixed on his bench. It is manufactured by The Grand Rapids Machinery Co., Grand Rapids, Mich.

Several Ways of Preventing Ice from Melting too Rapidly.

There are three or four things that will help to keep the precious nugget of ice from melting away if the housekeeper will only remember them. One is, that to keep ice warm is the way to keep it cold. A piece of ice in a pitcher, with a pail over the pitcher and a rug over the pail, will keep all night. A piece of ice in a refrigerator, covered with a snug white blanket, will cheat the greedy iceman every day and snap saucy fingers at the milk that does not dare to get sour or the beefsteak that dares not fail. These things are admirable in their way, and should be in every hatband, but the greatest trick of all is newspapers. With plenty of newspapers above, below, and on every side, the way a piece of ice will keep is a joke.—*Chicago Herald.*

Continued from page 5.

would have to use a larger cylinder for compound, as the two strokes of simple piston would give 2,261,952, but would use twice the volume of steam.

Now for the different conditions, as you will notice in all experiments, they use an excess of pressure over the simple engine; in this they have the advantage, first, from the fact that it has been demonstrated that it is not any saving whatever to compound at low pressures, the mean average being so low as to lose the benefits, and the exhaust cannot be kept up to proper degree with properly proportioned cylinders. On the other hand, the use of this enormous pressure, when cut off to a degree to get the full benefit of expansion, causes the cylinder to cool to that degree that there is a loss when you admit fresh steam, but giving them every advantage we have the following results under different conditions. An engine compounded in the proportion of two to one, and carrying one hundred and seventy pounds of steam, would have a maximum mean pressure of ninety-three and three-tenths pounds on high-pressure cylinder and forty-six on low-pressure cylinder when cut off at three-quarter stroke, while a simple at same cut off, but carrying only one hundred and fifty pounds, has a maximum mean pressure of one hundred and twenty-two pounds. This would give, using the same-sized cylinders as before, twenty inches for high and twenty-eight and about five-sixteenths for low-pressure cylinders, the following comparison: Area 313.13 x pressure 93 x stroke 24 + area 32,832 x pressure 46 x stroke 24 = 1,394,865, while the simple engine with the same admission, or if you will pardon the term, one mouthful of steam at one hundred and fifty pounds would give area 314.16 by pressure 122 x stroke 24 = 919,848, but if she completed her revolution and made two strokes, which the compound has to do, then she would develop 1,839,696, which would call for a compound to be high-pressure cylinder twenty-two and three-quarters with a low-pressure cylinder thirty-two and one-quarter inches diameter to do the same work as simple engine of twenty inches diameter same stroke, but using 170 pounds on compound as against one simple, while, not to make too many comparisons, we find the proportions coming closer together as we cut off shorter, until we get to one-third stroke, where the same sized cylinder for high-pressure of compound, as for simple engine does just the same work, holding the same difference in steam pressures. Of course by moving platforms and stations these proportions could be applied, or we can use four cylinders. But right here comes in the question of true economy, varying as the comparative cost of fuel and repairs vary. If the cost of repairs is increased by the extra sizes, especially weights of reciprocating parts, which have in turn to be counterbalanced, then the economy is reduced in just that degree, and, as repairs do not vary in cost per mile run in the same degree as coal does in different parts of the country, what might be a great economy at one point would only just balance in another.

You will notice that in all reports, so far made, there is nothing definite given. The Webb engine, imported from England, has developed about the same power, after starting, as one of our 17-inch engines of the seventy type, but you would not tolerate her one trip on account of starting with more than about four cars. The Lake Shore report says she did good work with some degree of economy with freight, but when put on passenger, they had to cut her valves, thus lessening her power for the sake of speed. Another thing, this report only covers five cars on a level road at 50 miles per hour. My deductions, after years of observation and study on this point, that there is a combination of points in compounding (of which the higher pressure is not the least) making it possible to do the same work with about 15 per cent. less fuel; that at least one-half of this is lost in repairs, where fuel and repairs to mile run are nearly equal. That when such men as compose the Western Railway Club, while acknowledging their belief in compounding, declare that they do not know why there should be or is any such economy; then there is nothing for it but to experiment and observe the results of different proportions and design.

Mr. Angus Sinclair, editor of the *National Car and Locomotive Builder*, is a man with whom I discuss all such matters more than any other. Before he went to Europe he was a strong advocate of compounding; after his return, I quote: "It is an open question, there being the most violent conflict of opinion on the subject among locomotive superintendents in Europe, where they ought to know all the comparative values. A month spent in the home of the compound locomotive took away a great deal of the faith previously held in that type of engine."

I have not heard of any of these gentlemen who have ordered compounds advancing any novelties in their construction, and the only thing they gain in owning them is that they can observe at home what all of us can get the data of from others, their actual gain or our loss being but a very small amount in dollars and cents, which we can well afford to lose for one year, if at the end the engine is better proportioned for adoption.

Yours truly,

P. LEEDS, S. M.

In this country about two men are sufficient to hold up an express train and quietly gather in the valuables. They appear to do things differently in Cuba. An organized band of robbers there recently made elaborate arrangements to derail a train and then secreted themselves on each side of the road to gather in the effects of the passengers. The derailment came off according to programme, but when the attack on the passengers was made the latter opened fire and easily put their assailants to flight.

In a report on a collision which occurred on April 29th, at Raynes Park station, on the London and Southwestern Railway, Major Marindin says the collision, which was due to a series of mishaps and blunders, "shows the value of disk signals at cross-over roads for shunting operations, even when close to a signal box; for with a proper system of interlocking the points must be properly set before a signal is given for a train to cross, which is not the case when hand signaling is made use of."

The cruiser Philadelphia has made her trial trip, and although at this writing it is uncertain with what speed she will be credited, it appears certain that she has so far exceeded the contract speed of 19 knots as to give the Cramps a handsome bonus. The firm gets a bonus of $50,000 for every quarter knot above 19, and forfeits a like sum for every quarter knot below. The Philadelphia is 335 feet long, 48½ feet beam, and 12 feet 2 inches deep.

The Chicago Board of Trade urges upon Congress the propriety of completing the improvement of the Mississippi River. That river is a great national highway, and very few will find fault with the spending of a few millions of the famous "surplus," to put it in condition to fulfill its mission.

Another complication in the ice business comes from the shipment of ice from Norway to New York. Ice will be shipped here from Norway until, as is to be hoped, the price in New York is largely reduced. Success to the Norway shippers.

It is said that the consumption of ice in New York, Brooklyn and Jersey City is more than two million tons annually. What an opening for ice-making machinery.

Machinists' Supplies and Iron.

NEW YORK, June 28, 1890.

Iron—American Pig.—A tendency toward greater weakness has developed during the week, the demand from consumers having fallen off somewhat,

BRADLEY HAMMERS AND FORGES.

The BEST HAMMERS in the WORLD RUN BY BELT.

Over 1500 In Use.

Three Styles, 15 lb. to 500 lb. Heads.

Our FORGES heat irons fast enough to keep Hammers and men fully employed.

Send for Catalogue and Prices.

BRADLEY & COMPANY, Syracuse, N. Y.

14 Warren St., NEW YORK. 18 Sudbury St., BOSTON.

VALVE MOTION.

Sinclair's Locomotive Engine Running and Management.

15th EDITION. PRICE $2.00.

A NEW BOOK RATHER THAN A NEW EDITION.

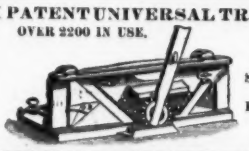
JNO. WILEY & SONS,

53 E. 10th St., NEW YORK.

THE FOX PATENT UNIVERSAL TRIMMER

OVER 2200 IN USE.

ORIGINAL Saves Time, Three Sizes,

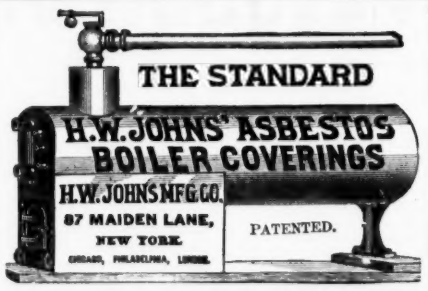


IMPROVED Saves Money. From New Patterns.

NO PATTERN ROOM COMPLETE WITHOUT THEM

Send for circular. Mention this paper.

THE FOX MACHINE CO., GRAND RAPIDS, MICH.



ASBESTOS CEMENT FELTING,

FOR LAGGING LOCOMOTIVE BOILERS.

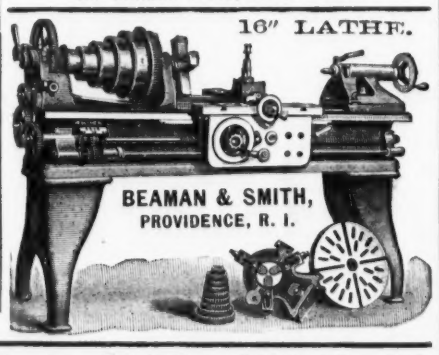
Samples and Descriptive Price List Free by Mail.

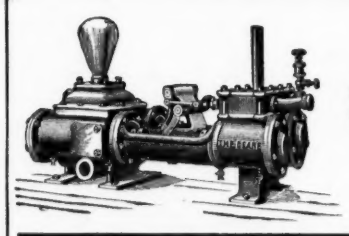
We are prepared to take Contracts for applying Steam Pipe and Boiler Coverings in any part of the United States.

H. W. JOHNS MANUFACTURING CO.,

87 Maiden Lane, NEW YORK.

16" LATHE.





THE DEANE

OF HOLYOKE

STEAM PUMPS

DEANE STEAM PUMP CO.,

HOLYOKE, MASS.

BEST STEEL

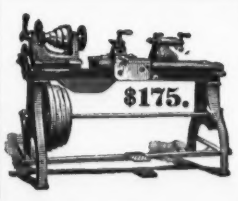
For Taps, Dies, Punches, Milling Cutters, Lathe and Planer Tools, Cold Chisels, Edged Tools and Hardware of all kinds.

CRESCENT STEEL CO.,

136 FIRST AVE., PITTSBURGH, PA.

64 & 66 So. CLINTON ST., CHICAGO, ILLS.

480 PEARL STREET, NEW YORK, N. Y.



Improved Screw Cutting Foot and Power **LATHES**

Drill Presses, Shapers, Band, Circular and Scroll Saws. Machinists' Tools and Supplies. Lathes on trial. Catalogue mailed on application.

THE SEBASTIAN-MAY CO., 167 W. 2d St.,

CINCINNATI, O.

MONTGOMERY & CO., 105 Fulton St., New York, Gen'l Agents.

TOBIN BRONZE

Tensile Strength upwards of 79,000 lbs. per sq. in.
Torsional Strength equal to the best Machinery Steel.
Anti-Frictional and Non-Corrosive.

CAN BE FORGED HOT.

Rods for pumps and bolts. Yacht shafting. Rolled sheets and plates for pump linings and condenser tube sheets, &c. Ingot metal for car and engine bearings. Spring wire.

ANSONIA BRASS & COPPER CO.,

Sole Manufacturers.

Send for Circular. CHICAGO. NEW YORK.

GEO. F. BLAKE MANF'G CO.

BUILDERS OF EVERY VARIETY OF

95 & 97 LIBERTY ST., NEW YORK. 111 FEDERAL ST., BOSTON.

WATER WORKS PUMPING ENGINES A SPECIALTY

BETTS MACHINE CO., WILMINGTON, DEL.

MAKERS OF

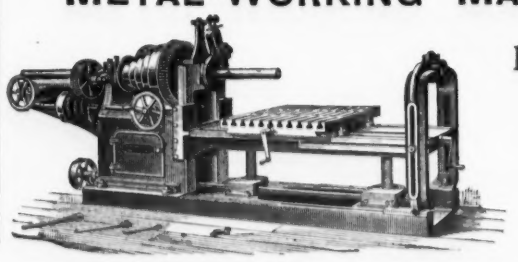
METAL-WORKING MACHINE TOOLS

FOR

Locomotive, Bridge & Engine Builders, Railroad, Car & Machine Shops

AND

Iron and Steel Works Generally.



especially in the West. At this season of the year many large consumers of iron shut down their works for repairs, and it is thought that when operations are resumed by them a firmer tone will result. Both Northern and Southern furnaces have been making some concessions.

We quote Northern No. 1 Foundry, $18 to $18.50; No. 2, $16 to $17. Southern No. 1, $17 to $17.50; No. 1, Soft, $16.50 to $16.75; and No. 2, $16 to $16.25.

Scotch Pig—The demand has been moderate. We quote Eglinton, $18 75 to $19; Dalmellington, $20.50 to $21; Coltness, $23.50 to $24.

Bar—The demand has been fairly good and the market firm.

We quote Common, $1.85; Medium, $1.90; Refined, $1.95 to $2 for round lots on dock.

Copper—Nothing new has developed during the past week, and the market has ruled firm. A strike which was threatened at the Calumet and Hecla was averted by the payment of higher wages by the company.

We quote Lake, 16¾c. to 17c.; Casting brands, 11½c.to 14¾c.; Arizona, 15¼c. to 15½c.

Lead—Though the demand has been very moderate, the market has ruled firm, and in sellers' favor.

We quote for prompt and near delivery, 4.60c. to 4.65c.

Spelter—The demand has been moderate, but sellers have been firm.

We quote ordinary brands of Western, 5.45c. to 5.60c. Choice, 5.70c. to 5.75c. Refined, 6¾c. to 7c. Silesian, 6⅞c. to 7c.

Tin—Prices have fallen somewhat, on account of reported heavy shipments, said to be on the way from Europe. Prices range from 21½c. to 21⅜c., according to amount purchased.

Antimony—Supplies are light and firmly held, with demand moderate.

We quote Hallett's, 20c. to 20¼c., Cookson's, 25 c. to 26c.

Lard Oil—The market has ruled quiet, with prices at 49c. to 50 c. for Prime.

✻WANTED✻

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Exp'd machinist desires sit. M. E., AM. MACH.

Wanted—A lot of good machinists. Address Frick Company, Waynesboro, Franklin Co., Pa.

Wanted—A few first-class machinists. State experience, age, habits, etc., and give reference. The Canton Steam Pump Co., Canton, O.

Wanted—Some moulders and machinists on engine work, about 40 miles from New York City. Address BOX 35, AMERICAN MACHINIST.

Wanted—Scrapers and filers, two or three first-class men; steady work and good pay to competent men. Fitchburg Machine Works, Fitchburg, Mass.

Wanted—A 1st-class boiler maker to lay out work. State age, and wages expected. Within fifty miles of New York. Address J., AMERICAN MACHINIST.

Wanted—Position by draftsman 30 years of age, 8 years exp. on blast furnace, steel plant and rolling mill work. "Steel Plant," AM. MACHINIST.

Machinist with technical education, aged 25, good lathe and vise hand, wants steady position, N. Y. City or vicinity. "W. A. M.," AM. MACHINIST.

Machinists Wanted—First-class floor hands and fitters of large experience and of good habits can find steady employment and liberal wages. Address Morgan Engineering Company, Alliance, O.

A draftsman and designer of machinery desires to correspond with parties having ideas to develod or special work to be put into shape for practical construction. BOX 33, AMERICAN MACHINIST.

Wanted—Machinist who has had experience building automatic high-speed engines, to take charge of department. State experience and salary. A. Robb & Sons, Amherst, N. S., Canada.

Wanted—Tool maker; first-class man only, to whom steady work and good wages will be offered. State qualifications and reference in confidence. Address "Cleveland," care AM. MACHINIST.

Wanted—A 1st class blacksmith on general light work. Address, stating age, experience, past and present employers, The Taunton Locomotive Manufacturing Co., Taunton, Mass.

Draftsman wanted—Experienced in mechanical and general designing. Address or apply to, stating age, exp., refs., and compensation expected, The Yale & Towne Mfg. Co., Stamford, Conn.

Wanted—A situation by a practical draftsman and inventor with twenty years experience in building silk, cotton and woolen looms. Address A. B., 30 Jackson street, Worcester, Mass.

Wanted—Two or three first-class lathe hands. Those accustomed to steam engine work, 5 to 50 H. P., preferred. Steady work and good pay to the right men. Troy Engine & Mach. Co., Troy, Penn.

Machinists Wanted—Fifty first-class bench and machine hands wanted. Only those acquainted with high-class machinery need apply. Steady work and liberal wages. Address, Dominion Typograph Co. (Limited), Windsor, Ontario.

Wanted—Several first-class machinists and toolmakers; good wages; pleasantly located shops; best of tools, and splendid openings for advancement of the right men, at Cleveland, O. Address Box 32, care of AMERICAN MACHINIST.

Wanted—Foreman for machine shop, and a lot of good machinists on new and repair work; also a clerk to take time, weights, and make up machine shop accounts. State age, experience, and wages expected. Beall Machine Works, Cumberland, Md.

A thorough practical machinist, age 37, having six years' experience as master mechanic, desires a similar position or a foremanship; familiar with stationary, mill and jobbing work; railroad shop preferred; will go to any part of U. S. or Mexico. Address F. H. B., AMERICAN MACHINIST.

Wanted—To add to office force in large shops in Chicago, one or two draftsmen experienced in Corliss and general engine designing, also one or two draftsmen experienced in mill building, constructions and general machinery. Address Box 40, AMERICAN MACHINIST.

Wanted—1st class machinist to take full charge of shop of about 25 hands on good class of work; prefer man with a little capital, and one posted on presses, dies and special machinery; rare chance to right party. Address Toledo Machine and Tool Works, Toledo, O.

Wanted—Mechanical engineer for a large machine works. Must be able to design, estimate and construct rolling mills and furnaces, engines, mining and hydraulic machinery, heavy gearing and general heavy machinery. The right man will find this a good opportunity for advancement. State age, experience, and salary expected, and send copies of references. Address Box 37, AM. MACHINIST.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 15 cents per line, each insertion.

Cheap 2d-h'd Lathes & Drills. S. M. York, Clev'd, O.

Koopman's Scales for quick measurements.

Just out; aluminum-steel hack-saws, hard but not brittle. Crescent Mfg. Co., Cleveland, Ohio.

New catalogue of engineers' specialties free. Crescent Mfg. Co., Cleveland, Ohio.

Light and fine machinery to order; Foot Lathe. Catalogue for stamp. E. O. Chase, Newark, N. J.

Turned and Highly Polished Iron and Steel Shafting a specialty. Merwin McKaig, Cumberland, Md.

Complete list of our Scales and other new tools for 2c. stamp. A. T. Koopman, Chicago.

Wanted—Customers for our new Radial Drills. C. H. Baush & Sons, Holyoke, Mass.

2nd-hand machinery, in good order; very cheap. Maslins, 165 First street, Jersey City, N. J.

Wanted—2d-hand engine lathe 36" to 50" swing. Chester Greenwood, Farmington, Maine.

See advertisement "Machine Tools for Sale" in Business Specials column. Logan Machine Works, Oil City, Pa.

Wanted—By two practical pattern makers, a location to start a pattern shop. Prefer power furnished. Address Box 34, AMERICAN MACHINIST.

Engineers wanted to send their addresses and receive free a 25 cent book, "Hints and Suggestions for Steam Users." Lord & Co., P. O. Box 1202, Phila., Pa.

Wanted—To buy second-hand lathes, planers and shapers of all sizes. Must be cheap and in good order. Fosdick & Plucker, 6th and Culvert Streets, Cincinnati, O.

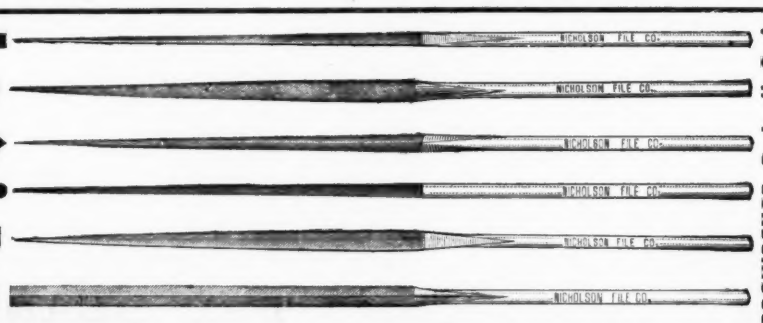
How to remove and prevent scale in steam boilers at a cost of ten cents a week. Send postal for circular to Pittsburgh Boiler Scale Resolvent Co., Pittsburgh, Pa.

For Sale or Lease—A manufacturing block, 40,000 feet floor space; 150 horse-power engine, shafting and elevators, in the center of this city. Railroad track in rear, surrounded by depots, good yard room. Will divide premises if desired, or will take an interest in an established business that could occupy same. Address The Brightman Machine Co., Cleveland, Ohio.

STEVENS PATENT
NEW EXACT SURFACE GAUGE

Superior to all others in quick, fine adjusting powers, especially in grasp of pointer. Also adapted to a depth gauge and various purposes.
Price, each small size, 8 inches.....$2.00
Price, " large " 12 ..... 2.75
Ideal and Leader Spring Dividers and Calipers, Depth Gauges, and Fine Machinists' Tools.
☞ *Illustrated catalogue free to all.*
J. STEVENS ARMS & TOOL CO.,
P. O. Box 231, Chicopee Falls, Mass.

FILES and RASPS.

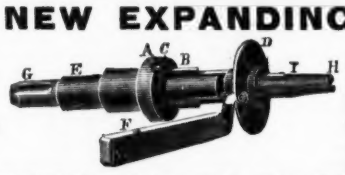


PROVIDENCE, R. I., U. S. A.

LECOUNT'S NEW EXPANDING MANDREL.

Amateur's Size.

Taking anything from ⅛ to 1 inch inclusive.
Price.....$5.00
Patented Dec. 25, 1877.



Machinist's Size.

No.			Price.
1	⅛ to 1	in.	$10
2	1	" 1½ "	14
3	1½	" 2 "	18
4 (with screws)	2	" 3 "	32
5 "	3	" 4 "	44

IF YOU WILL TRY THIS TOOL YOU WILL NOT REGRET THE EXPENSE.
C. W. LECOUNT, SOUTH NORWALK, CONN.
SPECIAL MANDRELS FOR SPECIAL JOBS MADE TO ORDER.

JESSOP'S STEEL
For TOOLS, DRILLS, DIES, &C.
All Kinds in Stock.
Gold Medal, Paris, 1889.
MANUFACTORY,
WILLIAM JESSOP & SONS, L'D. | SHEFFIELD, ENGLAND. | Chief American Office, 91 JOHN ST., NEW YORK.

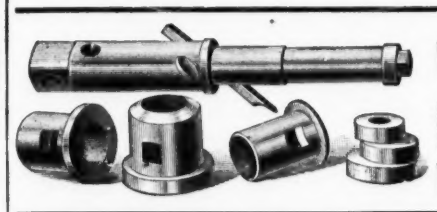
FITCHBURG
Machine Works,
Manufacturers of
METAL-WORKING MACHINES.
Office and Works,
13 to 21 Main Street,
FITCHBURG, MASS.

SEND FOR CATALOGUE (E.)

STANDARD OIL CUPS.
FOR HIGH SPEED ENGINES & MACHINERY.

DYNAMOS.
A. J. WILKINSON & CO.,
184 Washington Street,
BOSTON, MASS.

—THE—
Vance Lightning Flue Cutter

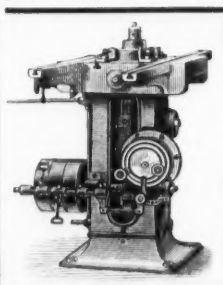


For removing Flues from Locomotive and Stationary Boilers. One man can cut five hundred (one end) in a day. In use in the leading Railroad Shops of the country. Combination Cutter for removing 2 in., 2 1-4 in., 2 1-2 in. and 3 in. flues, $50. Sent on approval to Railroad Co's. Liberal Discounts to the Trade.
VANCE TUBE CUTTER CO., Geneva. N. Y.

MINER & PECK MFG. CO.,
W. W. MINER, G. W. PECK, S. PECK, Proprietors.
Successors to
BEECHER & PECK,
Sole Manufacturers of
THE PECK PATENT DROP PRESS.
NEW HAVEN, CONN.

TO INVESTORS OR MANUFACTURERS.
FOR SALE —A desirable article to manufacture,
—A line of heavy machinery
—Which has been well tested.
—Is now in practical use.
—Secured by Patents.
Address, NOTTAD,
Box 44. E. DES MOINES, IOWA.

HENRY CAREY BAIRD & CO.,
INDUSTRIAL PUBLISHERS, BOOKSELLERS AND IMPORTERS,
810 Walnut St., Philadelphia.
☞ Our New and Revised Catalogue of Practical and Scientific Books, 80 pages, 8vo., and our other Catalogues and Circulars, the whole covering every branch of Science applied to the Arts, sent free and free of postage to any one in any part of the world who will furnish his address.



KEY SEATERS
PORTABLE AND STATIONARY.
RACK-CUTTING AND KEY-MAKING ATTACHMENTS.
GIANT KEY-SEATER CO.,
EAST SAGINAW, MICH.

BUFFALO FORGES.
BUFFALO FORGE CO., BUFFALO, N. Y.

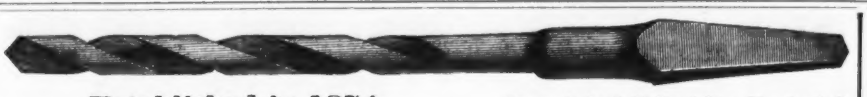
Dodge Independence
Wood Split Pulleys.
Lighter than Iron.
Greater traction than Iron.
Bushing system allows each pulley to be fitted to 22 sizes of shafts.
COOKE & CO., Sales Agents,
22 Cortlandt St., New York.
Shafting, Hangers, Engines, Boilers, Etc.
Write for prices, mentioning this paper.

JUST PUBLISHED.
1 Vol. 12mo., cloth, $1.50.
SLIDE VALVE GEARS.
AN EXPLANATION OF THE ACTION AND CONSTRUCTION OF PLAIN AND CUT-OFF SLIDE VALVES.
BY
FREDERIC A. HALSEY,
MECHANICAL ENGINEER.
FULLY ILLUSTRATED.
ANALYSIS BY THE BILGRIM DIAGRAM.
D. VAN NOSTRAND COMPANY,
23 Murray and 27 Warren Sts., New York.
Copies sent by mail on receipt of price.

THE BRITISH & EUROPEAN PATENT AGENCY,
F. W. BARKER, Manager,
(Registered English Patent Agent According to Act of Parliament,)
252 BROADWAY, NEW YORK.
European Patents obtained at low rates and sold on Commission through London House. *A good Invention is worth as much in Great Britain as in the United States.* Competent draftsmen employed on the premises, and special terms allowed inventors also obtaining their U. S. patents through the Agency. (CORRESPONDENCE SOLICITED.)

"Star" Foot Lathe Swings 9x25 in.
LATHE
Screw Cutting Automatic Cross Feed, etc.
Scroll Saws, Circular Saws, Lathes Mortisers.
Catalogue Free of all our Machinery.
Seneca Falls Mfg. Co. 687 Water St., Seneca Falls, N.Y.

WORTHINGTON—HIGH DUTY—Pumping Engine
—FOR—
WATER WORKS
OVER 100,000,000 DUTY
—GUARANTEED—
SEND FOR RECENTLY ISSUED PAMPHLET
HENRY R. WORTHINGTON
NEW YORK CITY.

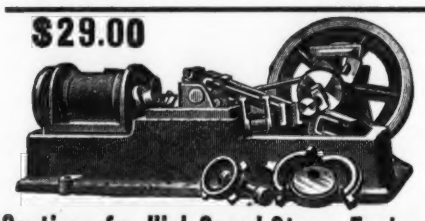


Established in 1874.

CLEVELAND TWIST DRILL CO.

Corner Lake & Kirtland Sts., Cleveland, O.
101 Chambers Street, New York.
85 Queen Victoria St., London, Eng.

$29.00



Castings for High Speed Steam Engine.

CYLINDER, 4 in. x 4 1-4 in.

T. SHRIVER & CO., IRON AND BRASS FOUNDERS,
333 E. 56th St., N. Y. City.

Sets of Castings for Engine illustrated above, with *Cast-steel Shaft*, *Connecting Rod* and *Rock Shaft* and *Brass Bearings*, boxed and shipped on receipt of $29.00. Three sheets *blue prints* of working drawings, extra.

DROP FORGING.

SPEIRS & MOORE, WORCESTER, MASS.

LATHE

FOR
TOOL MAKING,
MODEL MAKING.

Waltham, Mass.

SCREW CUTTING, GRINDING AND EXTRA FINE WORK.

SEND FOR BOOK OF DESCRIPTION

BEST SYSTEM on Earth for PUNCHING IRON AND STEEL.

STEAM **PARK** Double Jet **INJECTOR**

PARK MFG. CO.,
53 Portland Street,
Boston, Mass.

THE most reliable under varying steam pressure of any injector known. Will work from 15 pounds to 180 pounds without any adjustment. The only **Automatic Injector** that will thoroughly drain itself when shut off, thus preventing freezing. *Every Machine Guaranteed.*

INJECTORS AND JET APPARATUS.

BEVEL GEARS,

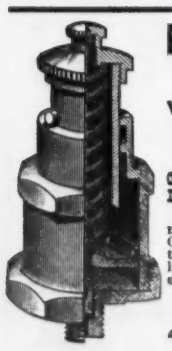
Cut Theoretically Correct.

For particulars and estimates apply to

HUGO BILGRAM,
Machinist,
Successor to
BREHMER BROS.,
440 N. 12th St., Philadelphia, Pa.

STUBS PATTERN FILES RIFFLERS NEEDLE FILES GROBET PATTERN STUBS WORLD IN THE BEST

McFADDEN CO.,
1025 MARKET ST., PHILADELPHIA.



LACKAWANNA GREASE CUP

Will Save its Cost in Oil alone Several Times per Annum.

SAVES ALSO IN LABOR AND COST OF COTTON-WASTE, PREVENTS DRIPPING AND SPATTERING.

A POSITIVE FORCE FEED with the most PERFECT REGULATION and GREATEST CONVENIENCE in operation yet attained in any device for the lubrication of machinery. Works equally well in every possible position.

Lackawanna Lubricating Co.,
41 Coal Exchange, Scranton, Pa.

SOME NOTABLE ARTICLES

APPEARING IN BACK ISSUES OF THE

AMERICAN MACHINIST.

The following list is published to facilitate the ordering of back numbers containing them. Any of these issues can be ordered through any newsdealer, or of the publishers direct, at the price then ruling, viz.: 5 Cents a Copy.

1886.

Pattern Making, Various Articles on. By F. W. Barrows. Appearing in 29 issues.
Foundry Practice, Various Articles on. By Robt. E. Masters, appearing in 16 issues.
Strength of Different Mixtures of Cast-iron and Method of Testing. By Robt. E. Masters, April 24.
Foundry Practice, Articles on. By Foundryman. [L. C. Jewett.] Aug. 14, Sept. 25, Dec. 18.
Foundry Practice, Articles on. By S. Bolland, May 8, 22, 29, June 26, July 10.
The Morton-Poole Roll Grinding Lathe. By Joshua Rose, J. G. Tramis, Geo. H. Babcock and C. A. Smith. July 3, 24, Aug. 7, 14, 21, Sept. 25.
Machine Shop Cost and Time Accounts. By A. J. Shaw, Henry Metcalfe and C. A. Burton, April 3, 17, May 8.
Tests of Iron. By David Spence, April 17, Oct. 30.
Traction on Grades. By A. B. Ropes, Oct. 30.
Wilson's Valve Gear for Locomotives, Oct. 30.
Casting Face-plates Face Up. By David Spence, Oct. 23.
A Job of Shaft Straightening. By F. L. Johnson, Oct. 23.
Inventory Valuation of Machinery Plant. By Oberlin Smith, Aug. 7.
Making a Cast-iron Sheave. By P. S. Dingey, July 31.
New Dredge Boiler designed by Norman Wheeler, July 17.
Core Oven with Rotating Back. By Thos. Wathey, July 24.
Universal Table for Lathe Change Gears for Screw Cutting. By Joshua Rose, July 24.
Gating, Clamping and Securing Chaplets. By Matthew Wiard, May 1.
Printing Frame and Manner of Making Blue Prints. By C. L. Redfield, July 31.
Some Pressure Tests. By C. O. Sine, Nov. 27.
An Expanding Mandrel—Turning Tapers. By Chas. S. Beach, Nov. 27.
Core Making in Foundries. By David Spence, Nov. 20.
Making Pattern for Spiral Grooved Drum. By Geo. Allge, Aug. 14.
Rolling Conic Sections Applied to Gears. By Geo. B. Grant, Nov. 6.
Ninety-inch Belpaire Fire-box Boiler, Nov. 6.
Spacing in the Milling Machine. By Chas. S. Beach, Aug. 21.
Engine Crossheads. By J. G. Tramis, Aug. 21.
Traction and Adhesion. By A. B. Ropes, Aug. 28.
Internal Key-seating on Milling Machines. By A. B. Landis, April 17.
Tapping Holes in Boilers. By A. B. Landis, April 24.
How to True Emery Wheels. By L. Best, April 24.
Work and System in the Drawing-room. By C. L. Redfield, Aug. 28.
Oiling Lathe Carriage Ways. By Wm. H. Bradt, Aug. 28.
Moulding a Screw or Worm without Cores. By George Allge, Sept. 11, 18.
Power Absorbed in Cutting Cast-iron. By James F. Hobart, Sept. 11, 18.
Moulding Screw Propellers in Loam. By Chas. A. Devlin, Sept. 18.
Dimensions of Wrought iron Pipes in England. By A. G. Brown, Sept. 4.
Truing Up and Replacing Milling Machine Centers with Accurate Alignment. By A. B. Landis, Jan. 16.
Methods of Working and Tempering Steel. By S. W. Goodyear, Jan. 9.
Slotting Tool. By J. J. Bingley, May 8.
How to Make Clean Solid Castings at Least Possible Cost. By Matthew Wiard, April 10.
Truing Milling Machine Centers. By W. R. Ballou, April 10.
Lining Engine Lathes. By Chas. S. Beach, April 10.
Steam Piping. By J. G. Tramis, April 10.
An Equalizing Dog. By A. B. Landis, April 10.
Screw Cutting Dies. By John J. Grant, April 10.
Some Handy Shop Tools. By Fred. H. Colvin, April 3.
Moulding Bells for Blast Furnaces in Green Sand Without Patterns. By Geo. O. Vair, April 3.
Furnace for Heating Long Bars. By W. G. Richards, April 3.
Cutting Tools—Roll Turning. By S. W. Goodyear Oct. 16.
Hydraulic Forging. By J. Richards, July 10.
A "Box" Jig. By C. E. Simonds, June 19.
Cheap Testing Machine. By Wm. Merrill, Feb. 6.
Boring Deep Holes. By A. B. Landis, Mar. 27, May 8.
Working Steel and Iron. By S. W. Goodyear, Feb. 13.
Inventory Valuations of Patterns. By W. E. Matheson and others, Jan. 9, Feb. 13, 20, Mar. 6.
Making Cast-iron Half Boxes. By A. J. Shaw, Feb. 6.
Draining Steam Pipes. By W. E. Crane, Feb. 6.
Brazing and Welding Iron. By J. F. Hobart, Mar. 6.
Deep Holes by Continuous Boring. By A. B. Landis, Mar. 27.
Slotting Machine Tool. By Wm. Foster, Mar. 20.
Compound Engines for Stationary or Factory Purposes. By W. H. Hoffman, April 24, May 1, 22.
Engineering Subjects, Articles on. By W. H. Hoffman, Mar. 13, July 24, 31, Aug. 21, Oct. 9.
Self-contained Engines. By W. H. Hoffman, Feb. 27, Mar. 6.
Curving Qualities of Locomotives with High and Low Centers of Gravity, Oct. 16.
Making Large Spur Gear Wheels. By P. S. Dingey, Oct. 2.
Normal Theory of the Gear Tooth Curve. By Geo. B. Grant, Mar. 13, 20, Oct. 9.
Return Tubular Boilers. By Wm. Lowe, Nov. 27, Dec. 4.
Chimneys for Steam Boilers. By Wm. Lowe, Mar. 27, May 15. By F. A. Halsey, May 1.
Railroad Cost Cards and Expense Sheets, April 24
The Milling Machine—Its Construction and Uses. By John J. Grant, Mar. 20.
Mechanical Arrangements of the N. Hudson County Cable Railway, Mar. 20.

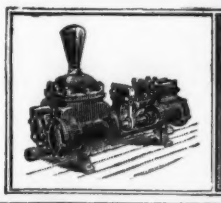
HALL DUPLEX STEAM PU

Send for 1890 Catalogue.

Fire Pump.

HALL STEAM PUMP CO.,
91 LIBERTY ST., NEW YORK.
PITTSBURGH. CHICAGO. ST. LOUIS.

Boiler and Pump Combined



THE BUFFALO STEAM PUMP CO.
BUFFALO, N.Y. — MANUFACTURERS OF
STEAM PUMPS
FOR ALL DUTIES.

WHY THIS IS PUT HERE!

For the reason that if you are interested in raising water or other liquids by steam power, we wish to call your attention to the

NEW PULSOMETER,

CHEAPEST & BEST STEAM PUMP IN THE MARKET. PRICES LOWER THAN ANY OTHER.
More Efficient, Simple, Durable, and more Economical, both as to running expenses and repairs, than any other Steam Pump.

Call or write for our new 96 page Illustrated Descriptive Book containing Full Particulars, Reduced Net Prices, and hundreds of A-1 Testimonials. Mailed Free.

PULSOMETER STEAM PUMP CO., 120 LIBERTY ST., N. Y.

COMPLETE STEAM PUMP
10 SIZES FROM $7 TO $75
FOR WATER SUPPLY TANKS, FIRE PUMPS & ETC.
WRITE FOR PRICES AND DESCRIPTIVE CIRCULARS
VAN DUZEN & TIFT
SOLE MAKERS
CINCINNATI, O.

Maslin's Patent Steam Pump.
Pat. Feb. 12, & Dec. 3, '89.

Cheapest and Best Automatic Steam Vacuum Pump. Handling DIRTY and GRITTY LIQUIDS without Wear, Oil or Care. Simple, Economical, Efficient & Durable. Pumping Plants for Contractors, Irrigation, Water Works, Railroads, Mining & General Hydraulic Purposes. Write or call for Circulars. JOHN MASLIN & SON, SOLE MANUF'RS, 165-167 1st St., Jersey City, N. J.

CRUCIBLE AND OPEN HEARTH CAMERON SELF-HARDENING STEEL

ESTABLISHED 1859.

HOWE, BROWN & CO., L't'd, Mfrs., Pittsburgh, Pa.

BRANCH OFFICES: 12 Cliff St., New York. 127 Oliver St., Boston. 228 Lake St., Chicago.

FRICTION CLUTCH PULLEYS AND CUT-OFF COUPLINGS

JAS. HUNTER & SON,
North Adams, Mass.

PATENT OILERS, CYLINDER SIGHT FEED CUPS.
Government Regulation
POP SAFETY VALVES,
For Stationary, Marine and Locomotive Boilers.
J. E. LONERGAN & CO., BRASS FOUNDERS AND FINISHERS,
211 Race Street, Philadelphia, Pa.
1888 CATALOGUE FREE ON APPLICATION.

WM. BERKEFELD'S FOSSIL MEAL COMPOSITION.

The best non-conducting material known for Steam Pipes and Boilers. Can be easily removed and repeatedly reapplied.

ITS PLASTIC NATURE INSURES AN ABSOLUTELY TIGHT JOINT.

Requires less thickness than any other covering.

FOSSIL MEAL CO., 2 Cedar St., N. Y.

Trade-mark. W. B. C.

STEAM HEATING.

Barnard's Condensing System will accomplish the following desirable features:

Saves Coal, Perfects the Circulation, Prevents all Noise, Prevents Freezing, Uses Exhaust Steam if any, without back pressure, will work at any pressure of steam, high or low. Has no Machinery needing care. Is adapted to Private Houses, Flats, Office Buildings, Hotels, Factories, etc.

GEO. A. BARNARD,
No. 15 Cortlandt St., NEW YORK.

8,200 Copies of "PRAY'S BOOK,"
20 YEARS WITH INDICATOR
Sold to March 30th, 1890. Vols. 1 and 2 in one vol., $2.50.
JOHN WILEY & SONS, 53 E. 10th St., N. Y.

P.H.&F.M.ROOTS,
Connersville, Indiana,
MANUFACTURERS OF
PORTABLE FORGES, TUYERE IRONS, ETC

ROOTS' NEW ACME HAND-BLOWERS
Slow-speeded, Force-blast. Durable, Compact and Cheap.
Roots' Foundry Blowers, Gas Exhausters, etc.
S. S. TOWNSEND, Gen. Agt. } 22 CORTLANDT ST.,
COOKE & CO., Selling Agts. } NEW YORK.

In Writing, Please Mention This Paper.

SUGGESTIVE FACTS FOR STEAM USERS.

BEMENT, MILES & CO., PHILADELPHIA.

After the fullest investigation, have just ordered a battery of 402 H. P. of Harrison Safety Boilers for the large addition now being built to their extensive works.

Pamphlet describing and illustrating the type of boiler they selected mailed upon application to

HARRISON SAFETY BOILER WORKS,

Germantown Junction, Philadelphia, Pa.

NEW YORK, N. Y. 41 Dey Street. | CHICAGO, ILL. 6 So. Canal Street. | ATLANTA, GA. 9 No. Pryor Street. | MINNEAPOLIS, MINN. 707 Lumber Exchange.

POND ENGINEERING CO.,

CONTRACTING ENGINEERS,

Engines, Boilers, Pumping Engines, Feed Pumps, Feed-water Heaters and Purifiers, Injectors, &c.

Send for ILLUSTRATED CIRCULAR.

St. Louis. Chicago. Kansas City. Omaha.

THOS. H. DALLETT & CO.

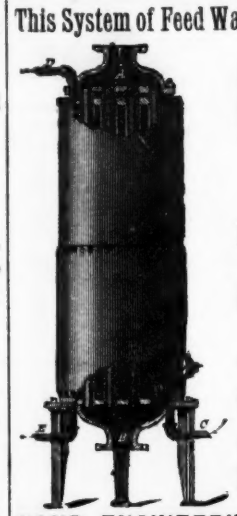
1305 Buttonwood Street,

PHILADELPHIA, PA.

Portable Drills, Hand Drills, Boiler Shell Drills, Light Drill Presses, Special Machinery.

SEND FOR CATALOGUE.

This System of Feed Water Heater is the Best



AND THE

LOWE

is the simplest

HEATER

on the System.

Has Straight Tubes

With reliable provision for expansion, and will

HEAT AND PURIFY THE WATER

EQUAL TO ANY

With same Feet of Heating Surface and

Wear the Longest.

Send for description and Histories of Boilers and Feed Water Heaters to

Bridgeport Boiler Works

Bridgeport, Conn.

POND ENGINEERING CO., AGENTS, ST. LOUIS, CHICAGO, KANSAS CITY, OMAHA.

WESTCOTT CHUCK CO., Oneida, N.Y., U.S.A.

MANUFACTURERS OF

LATHE and DRILL CHUCKS.

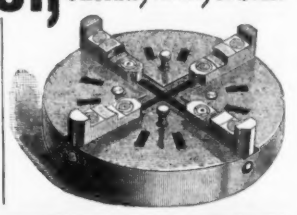
SEND FOR ILLUSTRATED CATALOGUE.

Independent Chucks,

Jaws Reversible.

Four Jaws.

Diameter.	Capacity.
7⅛ inch.	7⅛ inch.
10⅜ "	10⅜ "
13 "	13⅛ "
15¼ "	17 "
18 "	19¾ "
21 "	25½ "
24 "	28 "



Hydrostatic Machinery

PRESSES, PUMPS, PUNCHES,

ACCUMULATORS,

JACKS, VALVES, FITTINGS, &c., &c.

WATSON & STILLMAN,

204, 206, 208 and 210 EAST 43d ST., NEW YORK.

VOLNEY W. MASON & CO.,

Friction Pulleys, Clutches and Elevators,

PROVIDENCE, R. I.

"THE HORTON LATHE CHUCK"

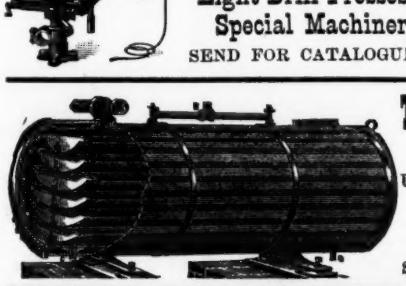
has sustained the tests and been the STANDARD for FORTY YEARS.

Over THREE HUNDRED sizes and styles of Chucks, made and kept in stock, by

THE E. HORTON & SON CO.,

WINDSOR LOCKS, CONN., U. S. A.

SEND FOR ILLUSTRATED PRICE LIST.



The HOPPES Live-Steam Feed-Water Purifier,

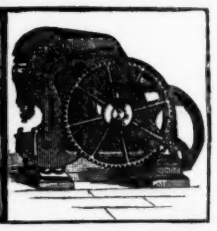
Guaranteed to Prevent Scale in Boilers.

Using any kind of water. Hard Sheet Steel Troughs, *Easily Cleaned.*

HOPPES MANUFACTURING CO.,

Send for Catalogue D. SPRINGFIELD, OHIO.

INDEPENDENT
4 JAW LATHE CHUCKS
WITH REVERSIBLE JAWS
MORE CHUCKS OF THIS STYLE ARE USED FOR GENERAL MACHINISTS WORK THAN ANY OTHER
FOR FURTHER PARTICULARS SEND FOR NEW DESCRIPTIVE CATALOGUE TO THE
USHMAN CHUCK CO.
HARTFORD, CONN.
SOLD BY ALL DEALERS
MADE IN 15 SIZES from 4½ inch to 26 in inclusive



"SWEETLAND" CHUCKS

SEND FOR DISCOUNTS.

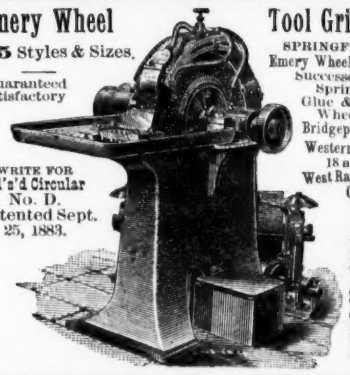
THE HOGGSON & PETTIS MFG. CO.,

Est. 1849. NEW HAVEN, CONN.

Emery Wheel Tool Grinder.

55 Styles & Sizes.

Guaranteed Satisfactory



SPRINGFIELD Emery Wheel Mfg. Co. Successors to Springfield Glue & Emery Wheel Co., Bridgeport, Conn. Western Branch, 18 and 20 West Randolph St. Chicago, Ill.

WRITE FOR Ill'd Circular No. D.

Patented Sept. 25, 1883.

Water Prevents HEATING THE WORK.

PINION KEY CHUCKS.

A geared scroll chuck with the pinion on the key shaft. It has been used for years by the largest electrical and instrument factories in the U. S. It is warranted durable and true. Ask for it at your dealer's.

THE D. E. WHITON MACHINE CO.

No. 5 Oak St., New London, Conn.

S. A. SMITH, 23 S. Canal St., Chicago, Western Agt.

Issues of the AMERICAN MACHINIST, March 22d, April 12th, May 10th, July 12th, 1884, containing Our Original Exposure of **FINK'S LUBRICATING MIXTURE HUMBUG**, sent by mail, at 5 cents per copy, postage paid.

REMOVES SCALE!

Engineers agree that our **Boiler Cleansing Compound** cannot be equalled

(LORD'S PATENT,)

for Removing and Preventing Scale in Steam Boilers.

Saves Fuel, Labor and Time, and prevents Corrosion in all its forms, and is guaranteed free from anything injurious to iron by the Chemists for United States Mint.

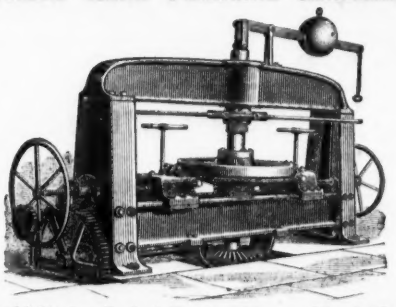
Engineers will receive free, on application, a 25-ct. book "HINTS FOR STEAM USERS."

BRANCHES: Baltimore, Md., New York, Pittsburgh, Pa., Chicago, Ill. and London, England.

S. W. Lord & Co., 11 So. 9th St., Philadelphia, Pa.

PREVENTS CORROSION!

O'BRIEN'S PATENT BOILER HEAD FLANGING MACHINE.



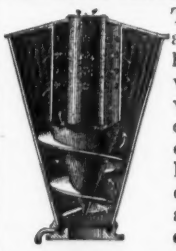
Rapid Work. Perfect Heads, with or without Dies. No Hole in Plate. Construction Simple. Price Reasonable.

JACOB CLARK, Mfr., Germantown, Philadelphia, Pa.

Steel Balls from $\frac{3}{16}$ inch to $2\frac{3}{8}$ inch for Anti-Friction Bearings a Specialty.

SEND FOR CATALOGUE.

SIMPSON'S CENTRIFUGAL EXHAUST HEAD.



Thoroughly entraps water and grease from the exhaust of a steam engine without back pressure, preventing them from spraying on the sidewalks and roofs of buildings; it protects the latter from injury, and passers by from annoyance and damage. Send for circular to

KEYSTONE ENGINE & MACHINE WKS.,

5th and Buttonwood Sts., Phila., Pa.,

Or A. T. ARTHUR, Selling Agent, 18 Cortlandt Street, N. Y.

GRAPHITE

Plumbago

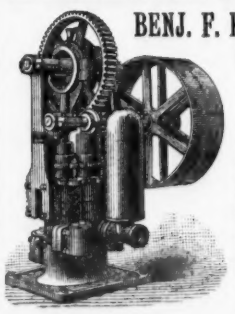
BLACK LEAD

Ground and prepared in quantities from ¼ lb. to a shipload. Lubricating Graphite a specialty. If you are at all interested in Graphite it will pay you to correspond with us, as different kinds are required for different purposes. All letters promptly answered.

Jos. Dixon Crucible Co.,

JERSEY CITY, N. J.

The Economic Boiler & Tank Feed-Pump



BENJ. F. KELLEY & SON,

91 Liberty Street,

NEW YORK.

It is a fact established beyond all dispute that the most economical of all methods of supplying steam boilers with feed water is by the use of a pump driven by a belt. The ECONOMIC PUMP is geared five to one. It is compact and systematic in design, and all parts are arranged for durability.

CHARLES MURRAY

ENGRAVER ON WOOD

58 ANN ST. NEW YORK.

SPRUE CUTTERS. SHEARS. TOGGLE-JOINT DRAWING PRESSES.

STILL IN THE LEAD!

THE ONLY AMERICAN FIRM

AWARDED

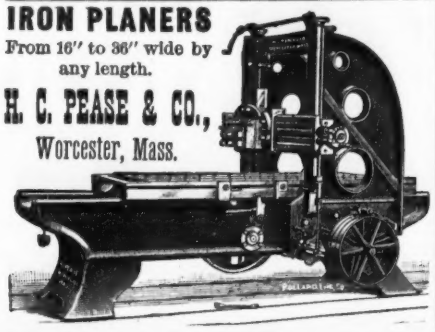
A GOLD MEDAL AT THE PARIS EXPOSITION 1889.

FOR SUPERIORITY IN PRESSES, DROP HAMMERS AND DIES.

THE STILES & PARKER PRESS CO.,

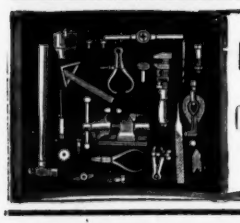
203-207 Centre Street, NEW YORK. MIDDLETOWN, CONN.

IRON PLANERS
From 16" to 36" wide by any length.
H. C. PEASE & CO.,
Worcester, Mass.



Pease Iron Planers.
All Sizes from 16 in.x16 in.x4 ft. to 36 in. x36 in.x12 ft. inclusive carried in stock.
HILL, CLARKE & CO.,
156 OLIVER ST., BOSTON, MASS.

MACHINISTS' FINE TOOLS.
STANDARD TOOL CO., ATHOL, MASS.
Catalogue and Price List free.



EVERYTHING FOR **MACHINISTS** in any quantity.
Chandler & Farquhar,
BOSTON, MASS.
Send for Catalogue.

ALUMINUM, $2 PER POUND.

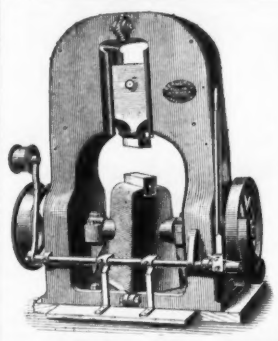
THE PITTSBURGH REDUCTION COMPANY, 95 Fifth Avenue, Pittsburgh, Pa., U. S. A., offer commercially pure aluminum at the following rates at Pittsburgh, Pa.:

Lots of 1,000 lbs. and over.....$2.00 ℔ lb
Lots of 500 lbs. and over..... 2.25 ℔ lb
Lots of 100 lbs. and over..... 2.50 ℔ lb

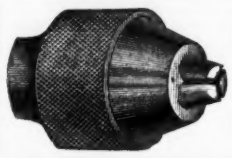
Metal guaranteed to be equal in quality to the best metal manufactured by any other process.

Prices on sheets, wire, tubes or castings given upon application.

OUR NEW **CATALOGUE OF TOOLS**
And Supplies sent free to any address on receipt of Ten Cents in Stamps (for postage).
Chas. A. Strelinger & Co., WOOD AVE. Detroit, Mich.



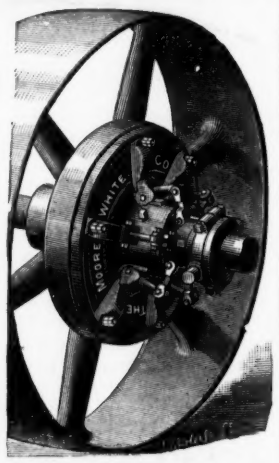
BEAUDRY'S NEW POWER HAMMER.
Send for Descriptive Circular.
BEAUDRY & CO., Sole Manufacturers.
Also Manufacturers of Hard Coal Heating Forges.
Room 4, Mason B'dg.
70 KILBY ST., BOSTON, MASS.



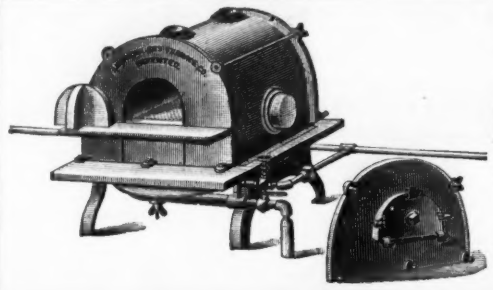
Almond Drill Chuck.
Sold at all Machinists Supply Stores.
T. R. ALMOND,
83 & 85 Washington St.
BROOKLYN, N. Y.

WELDLESS STEEL QUICK OPENING GATE VALVE COLD DRAWN TUBES
SMOOTH INSIDE & OUT.
JOHN S. LENG, 4 Fletcher St. N.Y.

THE MOORE & WHITE CO.,
Philadelphia, Pa.
Friction Clutch Pulleys, Cut-off Couplings, &c.



DRAWING INSTRUMENTS,
200 page Catalogue sent on mention of this Journal, by
C. S. WOOLMAN,
116 Fulton Street,
NEW YORK.

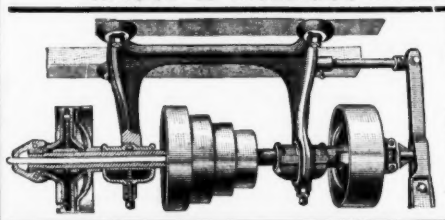


American Gas Furnace Co.,
Designers and Manufacturers
GAS BLAST FURNACES.
Send for Catalogue. Estimates made for any mechanical operation requiring **high, even** and **controllable temperature.**
No. 80 NASSAU STREET
NEW YORK.

HEAVY AND LIGHT **CASTINGS** IRON OR BRASS
ARTHUR R. KING FOUNDRY & MACHINE WORKS,
ERIE, 11th & 12th STS., JERSEY CITY, N. J.
GENERAL MACHINE WORK. CORRESPONDENCE INVITED.

FINE TAPS, DIES, REAMERS, ETC.

LIGHTNING AND GREEN RIVER SCREW PLATES.
Belt Cutters, Hand and Power Drilling Machines, Punching Presses, Tire Benders, Tire Up etters and Other Labor-Saving Tools. Send for Price List.
WILEY & RUSSELL MFG. CO., GREENFIELD, MASS.



A MODERN COUNTERSHAFT.
ATTENDS TO ITSELF.
A new and Perfect Friction Clutch. Self-oiling throughout. Self-oiling pulleys that do not spill. Tested by one year's use. Saves care, worry and money.
THE STATES MACHINE CO.,
R. R. Place and Commerce St., NEWARK, N. J.

SEND FOR CATALOGUE.
WORCESTER MACHINE SCREW CO.

Manufacturers of Set, Cap & Machine Screws, Studs, etc.

American Standard Gauge & Tool Works,
WILMINGTON, DEL.
Makers of Implements for Standard Measurements.

Over 43,900 in Use.

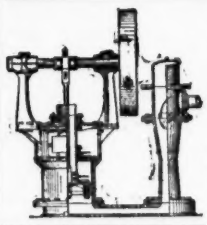
Crescent Gauge. Flat Bar Gauge.
JAS. A. TAYLOR & CO.

THE KEYSTONE HANDLE.
A permanent and reliable method of attaching Hammers and all Edge Tools to Handles. Address,
E. H. BROOKS, LEBANON, PA.

SHARTLE'S BULL DOG
THE HARDER YOU PULL, THE TIGHTER IT HOLDS.

Can't slip. No wrench required. Made from 1-2" to 8" or larger. Send for sample order subject to approval.
MANUFACTURED BY
MIDDLETOWN (OHIO) MACHINE CO.

PATENT UNIVERSAL DEPTH ANGLE AND SCREW-CUTTING CENTER
J. WYKE & CO., **TWIST DRILL GAUGE.**
Fine Machinists' Tools.—E. Boston, Mass.—Send for Circular.



Belt Power Air Pump and Condenser.
CONOVER & CO.,
CONSULTING AND MECHANICAL ENGINEERS
95 LIBERTY ST.,
NEW YORK.
No Air Locks 15 to 50 per cent fuel saved or equal amount of power gained. Runs with same economy as engine.
Adapted to all kinds of Engines. *Send for Circular.*

☞ Are you boring on Engine Lathes?

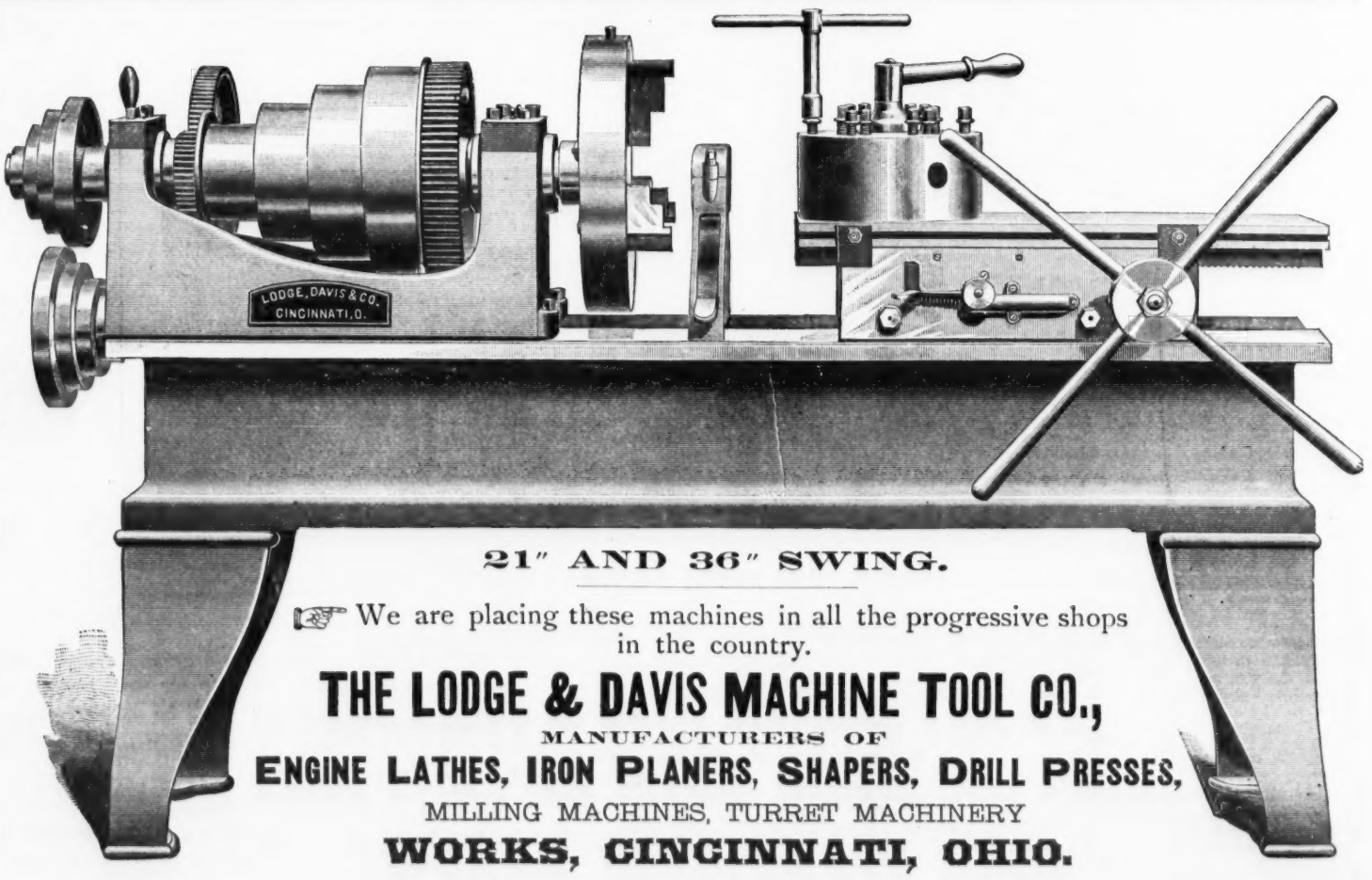
☞ Then you are losing money!!!

☞ Enough work bored on these machines to keep 20 Engine Lathes running.

☞ Automatic Revolving Turret.
☞ Automatic Feed to Turret.
☞ Automatic Stop to Turret.
☞ Large Hollow Spindle, 1⅞ hole.
☞ Extra Large Bearings.
☞ Combination Chuck with each machine.

EASTERN HOUSE:
64 Cortlandt Street,
NEW YORK.

WESTERN HOUSE:
68 & 70 S. Canal Street,
CHICAGO.



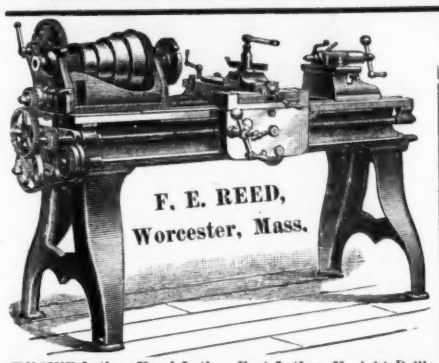
21" AND 36" SWING.

☞ We are placing these machines in all the progressive shops in the country.

THE LODGE & DAVIS MACHINE TOOL CO.,
MANUFACTURERS OF
ENGINE LATHES, IRON PLANERS, SHAPERS, DRILL PRESSES,
MILLING MACHINES, TURRET MACHINERY
WORKS, CINCINNATI, OHIO.

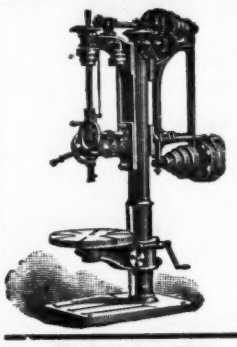
MORSE TWIST DRILL AND MACHINE COMPANY, New Bedford, Mass.
Manufacturers of **Morse Patent Straight-Lip Increase Twist Drills.**

Solid and Shell Reamers, Beach's Patent Self-Centering Chuck, Bit Stock Drills.
DRILL GRINDING MACHINES, MILLING CUTTERS AND SPECIAL TOOLS TO ORDER.

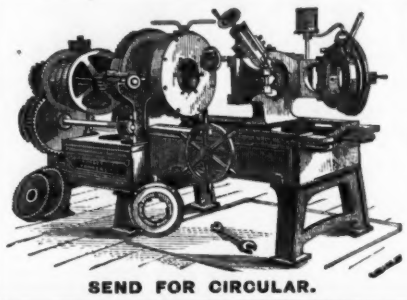


ENGINE Lathes, Hand Lathes, Foot Lathes, Upright Drills and Milling Machines. Agents, MANNING, MAXWELL & MOORE, 111 LIBERTY STREET, NEW YORK.

NEW HAVEN MANUF'G CO.,
New Haven, Conn.



Lathes, Planers, Shapers, Slotters, Etc.



SEND FOR CIRCULAR.

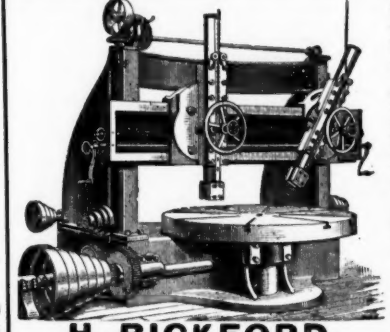
D. SAUNDERS' SONS,
Manufacturers of
Pipe Cutting & Threading Machines
For Pipe, Mill and Steam Fitters' Use.
TAPPING MACHINES,
For Steam Fitting, also
Steam and Gas Fitters' Hand Tools.
YONKERS, N. Y.

OLMSTED'S UPRIGHT DRILL.
Drills from 5-16 to smallest size with utmost sensitiveness.
No sleeves or collars on spindle to make friction. Spindle and feed lever connected by new adjustable double ball joint. The thrust is directly against center of spindle to feed Drill.
Price $18. Sold by all Machinist Supply Dealers.
SEND FOR CIRCULAR.
L. H. OLMSTED,
Hasbrouck Heights, N. J.

FLATHER ENGINE LATHES
14, 15, 16, 18, 20, 24 and 28 INCH SWING.
ANY LENGTH OF BED UP TO 22 FEET.
HILL, CLARKE & CO.,
General Selling Agents,
156 OLIVER ST., BOSTON, MASS.

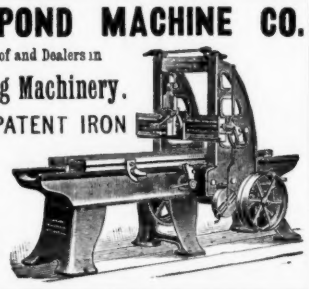
JUST OUT.
OUR NEW ILLUSTRATED CATALOGUE OF
Turret Machinery.
MANY NEW FEATURES.
JONES & LAMSON MACHINE CO.,
SPRINGFIELD, VERMONT.
SEND FOR IT.

Blaisdell Engine Lathes.
All Sizes from 14 in. to 30 in. swing carried in stock.
HILL, CLARKE & CO.,
156 OLIVER ST., BOSTON, MASS.

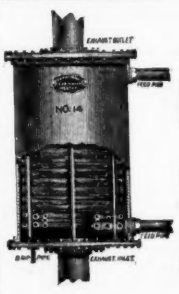


H. BICKFORD,
LAKE VILLAGE N. H.
BORING AND TURNING MILLS, 4, 5 and 6 Ft. SWING.

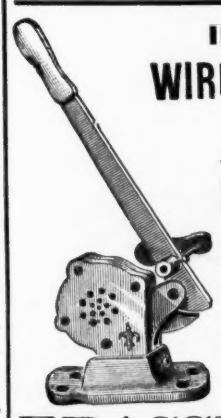
L. W. POND MACHINE CO.
Manufacturers of and Dealers in
Iron Working Machinery.
IMPROVED PATENT IRON PLANERS A SPECIALTY.
152 Union St., WORCESTER, MASS.



L. W. POND PLANERS.
FOR QUICK DELIVERY.
One Planer 38 in.x38 in.x10 ft., with 2 heads.
One Planer 44 in.x40 in.x12 ft., with 2 heads.
HILL, CLARKE & CO.,
156 OLIVER ST., - BOSTON, MASS.



THE NATIONAL Feed-Water HEATER.
A brass coil Heater delivering water to the boiler at 210° Fahrenheit.
300,000 Horse Power sold. Prices Low. Satisfaction universal.
THE NATIONAL PIPE BENDING CO.,
82 River Street, NEW HAVEN, CONN.



IMPROVED WIRE CUTTERS.
No. 1 cuts wire rods without leaving burr from ¼ in. to smallest size. Price, $7.00 each.
No. 2 cuts sizes from ⅛ in. to smallest size. Price, $12.00 each. Send $1.00 for 550-page illustrated catalogue of fine tools and supplies. No charge made when $10.00 worth of goods are ordered.
FRASSE & CO.,
92 Park Row, New York.

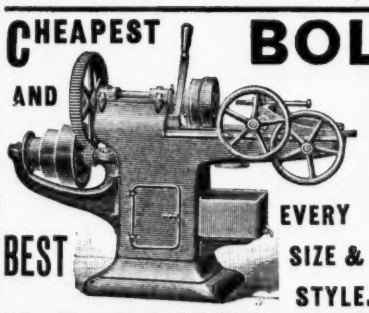
SCROLL SAWS
THE
FLEETWOOD & DEXTER
ARE THE BEST.
THOUSANDS SOLD.
Write for Illustrated Price Lists to
TRUMP BROS. MACH. CO.
Manufacturers.
WILMINGTON, DEL., U. S. A.

BARNES PAT. FOOT POWER MACHINERY.

I feel so highly pleased with your Velocipede Foot Power with seat, that I wish to add my testimony to its superiority. I did not expect to like it, but having used the Velocipede Power I would have nothing else. It so greatly lessens the fatigue of using foot power, in fact, it may be said to be almost without fatigue, and is a steadier motion. I only wish I had known of it sooner. SEND FOR CATALOGUE. W. F. & J. BARNES CO., 1995 Ruby St., Rockford, Ill.

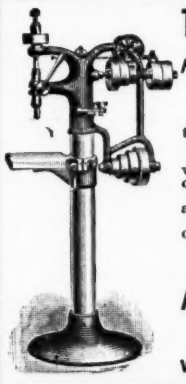
WORK SHOPS
Of Wood and Metal Workers without Steam Power, Equipped with Outfits of
BARNES' PATENT
Foot Power Machin'y
allow lower bids on jobs, and greater profits than by any other means for doing work. Sold subject to trial in your shop. Send for Price-List Catalogue.
W. F. & JNO. BARNES CO.,
Address 1995 Ruby St., ROCKFORD, ILL.

CHEAPEST AND BEST BOLT CUTTERS.



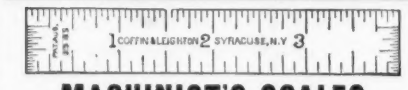
EVERY SIZE & STYLE.
H. B. BROWN & CO.,
EAST HAMPTON, CT.

THE NORTON DRILLS.
FOR LIGHT, SENSITIVE AND RAPID DRILLING.



1, 2, 3, 4 or more Spindles, Sensitive or Automatic Feed.
To drill from 0 to 1-2 inch holes.
The *Latest* and *Best*; most convenient, sensitive and durable Drill on the market.
Have Balanced Spindles and Balanced Tables.
Write for prices and description, or for Special Machinery.
NORTON & JONES,
Machine Tool Works,
PLAINVILLE, CONN.
FORMERLY
W. P. NORTON, BRISTOL, CONN.

L. S. STARRETT,
Manufacturer of
FINE TOOLS,
ATHOL, MASS.
SEND STAMP FOR FULL LIST.

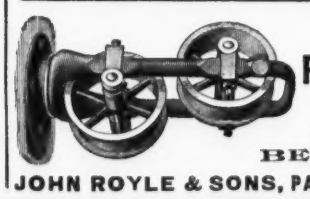


MACHINIST'S SCALES,
PATENT END GRADUATION.
We Invite Comparison for Accuracy with all others.
EVERY SCALE GUARANTEED. SEND FOR LIST.
COFFIN & LEIGHTON, SYRACUSE, N. Y.

GLEASON MACHINE TOOLS
Engine Lathes, 22 inch to 72 inch swing.
Iron Planers, 26 inch to 84 inch wide.
HILL, CLARKE & CO.,
156 OLIVER ST., BOSTON.

WILLIAM BARKER & CO.,
Manufacturers of
Iron and Brass Working
MACHINERY,
140 & 142 E. SIXTH ST.,
Near Culvert,
CINCINNATI, O.
Send for Circulars and Prices.

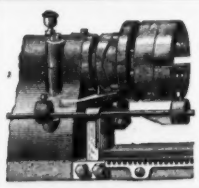
CURTIS & CURTIS,
6 Garden St., Bridgeport, Ct., U.S.A.
MANUFACTURERS OF
The Forbes Pat. Die Stock,
IMPROVED AND PERFECTED.
Pipe Cutting and Theading Machine, etc.
A portable cutting and threading machine with which one man can with ease thread pipe up to six inch diam. No vise is required.
SEND FOR ILLUSTRATED CATALOGUE.
Ratchet Drills, Ratchet Die Stocks and Malleable Iron Pipe Vises.



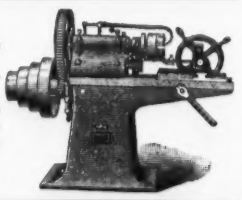
GUIDE PULLEYS FOR LIGHT BELTS.
JOHN ROYLE & SONS, PATERSON, N. J.

MACHINERY
For Reducing and Pointing Wire.
ESPECIALLY ADAPTED TO POINTING WIRE RODS AND WIRE FOR DRAWING.
For Machines or Information, address the Manufacturer,
S. W. GOODYEAR, Waterbury, Ct.

FACTORY, HOBOKEN, N. J.
Manufacturers of
Drawing Materials, Etc.,
Superior Swiss Drawing Instruments, Extra and Best Quality, German Drawing Instruments, Paragon, Duplex, Universal, Anvil Drawing, Helios, Blue Process Papers, Scales, Triangles, T-Squares, Drawing Boards, Standard Profile and Cross-section Papers.
Catalogue to professional people on application.



ADAMS
Automatic Bolt-Threading & Nut Tapping Machine.
Made in all Sizes to Cut from 1-4" to 6".
The simplest and most durable machine in existence. The threading head is made entirely of steel. No links, levers, springs, caps, cases, blocks or die rings in or about the head. Separate Heads and Dies Furnished. Write for descriptive circular and price list to
Capitol Mfg. Co., 125 to 137 Rees St., Chicago, Ill., U. S. A.



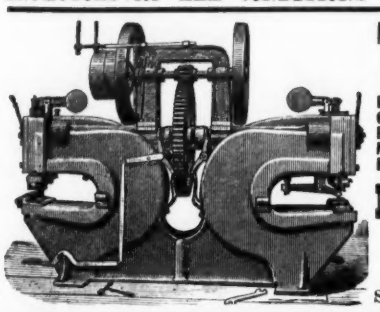
A NEW JAW
about once a year will make this Cutter last until you forget when you bought it, as the body never wears out.
Warranted to Cut Straight.

THE "EUREKA" PIPE CUTTER
IS THE BEST AND CHEAPEST MADE.
No. 1 Cuts ⅛ to 1 inch Pipe $1.00
No. 2 " ¼ to 2 " " 1.50
No. 3 " 1 to 2 " " 4.65
Nos. 1 and 3 will cut all sizes from ⅛ to 3 inch
Any Jobber can furnish this tool to you at these prices.
PANCOAST & MAULE,
243 and 245 South Third Street, Philadelphia.

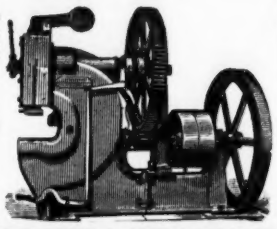
W. C. YOUNG & CO., Worcester, Mass
Manufacturers of
Engine Lathes, Hand Lathes,
FOOT POWER LATHES, SLIDE RESTS, ETC.

DAMPER REGULATORS.
Our Steam Damper Regulator is the most perfect and simplest machine in the market. Price, $60 and $100. Any one can apply it. Send for circular to Mason Regulator Co., Boston.

WILLIAM SELLERS & CO., Incorporated.
PHILADELPHIA, PA.
BUILDERS OF
MACHINE TOOLS FOR WORKING IRON AND STEEL
Improved TURNTABLES for LOCOMOTIVES, CARS and PIVOT BRIDGES.
High Speed Power Traveling Cranes and Hand or Power Swing Cranes, Shafting, Pulleys, Hangers, &c., for transmission of power. Improved Self-Adjusting Injector of 1876. Self-Acting Injector of 1887. Fixed-Nozzle Automatic Injector of 1885.
INJECTORS for ALL CONDITIONS of LOCOMOTIVE and STATIONARY SERVICE.



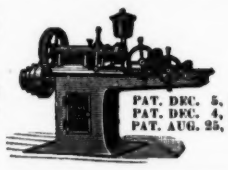
THE LONG & ALLSTATTER CO. Hamilton OHIO.
Double, Single, Angle-Bar, Gang, Horizontal, Twin, Boiler, Spacing, Gate, Multiple, Belt and Steam-Driven
Punches and Shears,
OVER 300 SIZES.
ALSO
Power Cushioned Hammer.
Send for New Catalogue.



OPEN SIDE IRON PLANERS FOR IMMEDIATE DELIVERY.
One 30 in.x25 in.x6 ft.
One 30 in.x25 in.x6 ft. with Extra Side Head.
Two 30 in.x25 in.x8 ft.
One 36 in.x30 in.x8 ft.
One 48 in.x48 in.x14 ft. with Extra Side Head.
One 48 in.x48 in.x16 ft. with Extra Side Head.
Also, One second-hand Bement Planer 42 in.x42 in.x17 ft. with three Heads. Good condition. Very cheap.

THE DETRICK & HARVEY MACHINE CO.,
BALTIMORE, MD.

ACME MACHINERY CO.
CLEVELAND, OHIO.
Manufacturers of
ACME BOLT & RIVET HEADERS,
Acme Single & Double Automatic BOLTCUTTERS.
Cutting from 1-8 in. to 6 in. diameter.
Also SEPARATE HEADS and DIES.
FIRST PREMIUM, CINCINNATI CENTENNIAL.



PAT. DEC. 5, 1882.
PAT. DEC. 4, 1883.
PAT. AUG. 25, 1885.

NICHOLSON & WATERMAN M'F'G CO.,
PROVIDENCE, R. I.
LATHES.
CUTTING-OFF MACHINES,
TRAVERSE DRILLS,
TRAVERSE BORING MACHINES,
SPECIALS,
&c., &c.

HORIZONTAL BORING MACHINES.

BOLT & NUT MACHINERY.
BROACHING MACHINES.
FACING MACHINES.
BOLT LATHES,
STAY BOLT THREADERS,
&c., &c.

WYMAN & GORDON,
WORCESTER, MASS.
DROP FORGINGS.

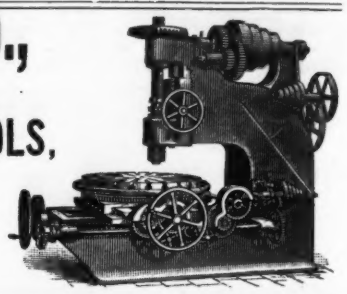
SAWYERS SAY OF SAWS FILED ON ROGERS' SAW FILER AND GUMMER, THAT OF ALL THE SAWS THEY EVER FILED THEY NEVER FILED SAWS AS THESE SAWS
Drop a postal card in the slot and get a Catalogue.
SAMUEL C. ROGERS & CO.,
BUFFALO, N. Y.

ESTABLISHED 1842.
ROBERT POOLE & SON CO.
ENGINEERS AND MACHINISTS.
MACHINE MOULDED GEARING.
ALL KINDS OF TRANSMISSION MACHINERY
OF THE HEAVIEST CLASS.
BALTIMORE, MD.

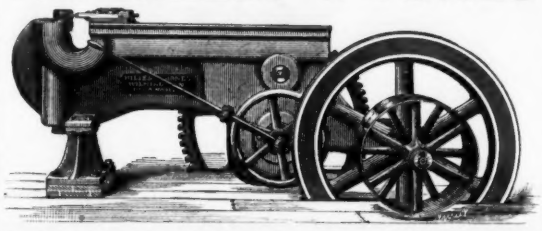
EMPLOYERS' LIABILITY ASSURANCE Corporation Limited London, Eng.
Deposited in the U. S. $700,000.00.
Policies issued giving full protection to Employers against loss by Claims from Employees on account of Accident. Rates Proportioned to Risks of Occupation. One Premium the only Payment during year. No Contingent or other Liability on part of Employer.
CHIEF OFFICE IN THE UNITED STATES:
71 KILBY ST., BOSTON, MASS.
ENDICOTT & MACOMBER,
Managers and Attorneys.
BOSTON: Samuel Appleton, 28 Central St.
NEW YORK: Kirby & Dwight, 51 Cedar St.
PHILADELPHIA: Tattnall Paulding, John G. Hoover, 416 and 420 Walnut St.
CHICAGO: Geo. A. Gilbert, 226 and 228 La Salle St.
ST. LOUIS: F. D. Hirschberg Bro., 120 N. Third St.
AGENTS IN ALL THE PRINCIPAL CITIES.

J. A. FAY & CO. CINCINNATI, OHIO, U.S.A.
BUILDERS OF IMPROVED
WOOD-WORKING MACHINERY
Embraces nearly 400 Machines for
PLANING & MATCHING
Surfacing, Moulding, Tenoning, Mortising, Boring, and Shaping, etc.
Variety and Universal
WOOD WORKERS.
Band, Scroll and Circular Saws, Resawing Machines, Spoke and Wheel Machinery, Shafting, Pulleys, etc. All of the highest standard of excellence.
W. H. DOANE, Pres. D. L. LYON, Sec'y.

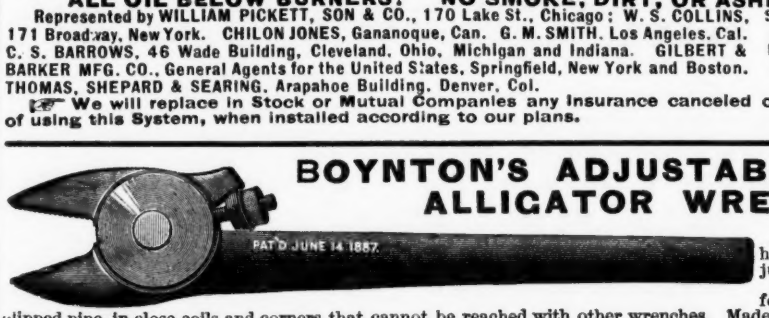
BEMENT, MILES & CO.,
PHILADELPHIA, PA.,
BUILDERS OF
METAL-WORKING MACHINE TOOLS,
FOR
RAILROAD SHOPS, LOCOMOTIVE AND CAR BUILDERS, MACHINE SHOPS, ROLLING MILLS, STEAM FORGES, SHIP YARDS, BOILER SHOPS, BRIDGE WORKS, ETC.



The HILLES & JONES CO., WILMINGTON, DELAWARE,
MANUFACTURERS OF
MACHINE TOOLS,
FOR
BOILER MAKERS, BRIDGE BUILDERS, SHIP BUILDERS, RAILROAD SHOPS, LOCOMOTIVE AND CAR BUILDERS, ETC., ETC.
HORIZONTAL FLANGE PUNCHES, ALL SIZES.



THE AERATED FUEL COMPANY,
425 MAIN STREET, SPRINGFIELD, MASS. J. H. BULLARD, MANAGER.
FORGING AND WELDING BY PETROLEUM AIR BLAST.
ALL OIL BELOW BURNERS! NO SMOKE, DIRT, OR ASHES!
Represented by WILLIAM PICKETT, SON & CO., 170 Lake St., Chicago; W. S. COLLINS, 171 Broadway, New York. CHILON JONES, Gananoque, Can. G. M. SMITH, Los Angeles, Cal. C. S. BARROWS, 46 Wade Building, Cleveland, Ohio, Michigan and Indiana. GILBERT & BARKER MFG. CO., General Agents for the United States, Springfield, New York and Boston. THOMAS, SHEPARD & SEARING, Arapahoe Building, Denver, Col.
Sept. 29, 1885
July 5, 1887
Feb. 5, 1889
July 23, 1889
☞ We will replace in Stock or Mutual Companies any Insurance canceled on account of using this System, when installed according to our plans.



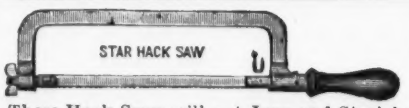
BOYNTON'S ADJUSTABLE ALLIGATOR WRENCH.
Quick and handy in adjustment. Invaluable for work on clipped pipe, in close coils and corners that cannot be reached with other wrenches. Made entirely of drop forged steel. *Four sizes.*
CAMPBELL PRINTING PRESS AND MFG. CO., MFRS.
160 WILLIAM ST., NEW YORK. 325 DEARBORN ST., CHICAGO.

Our Location, Foundry Capacity and Machine and Pattern Shop Equipment afford us **special facilities for furnishing HEAVY CASTINGS TO ORDER,** in any quantity up to size 20,000 lbs., or **SMALL CASTINGS** where large quantities are required. Get our estimates and prices before ordering.
ALLENTOWN FOUNDRY & MACHINE CO.,
3d and Walnut Streets, ALLENTOWN, PA.

All GENUINE INGOTS & MANUFACTURES BEAR OUR REG. TRADE MARKS.
"Phosphor Bronze."
PHOSPHOR-BRONZE
INGOTS, CASTINGS & MANUFACTURES.
THE PHOSPHOR BRONZE SMELTING CO. LIMITED
512 ARCH ST. PHILADELPHIA PA. U.S.A.
ORIGINAL MANUFACTURERS OF PHOSPHOR-BRONZE IN THE UNITED STATES AND OWNERS OF THE U.S. PATENTS.

THE CHESTER FOUNDRY & MACHINE CO.,
CHESTER, PA.
Builders of **CRANES** of every type and capacity, **MARINE, PUMPING** and **BLOWING ENGINES, CORLISS ENGINES, HYDRAULIC PRESSES, ACCUMULATORS,** and **SPECIAL MACHINERY** of every description. **CASTINGS IN DRY OR GREEN SAND AND LOAM.**

NO MACHINE SHOP CAN AFFORD TO BE WITHOUT
NICHOLSON'S EXPANDING MANDRELS.
Write for new Price List. W. H. NICHOLSON & CO., Wilkes-Barre, Pa.



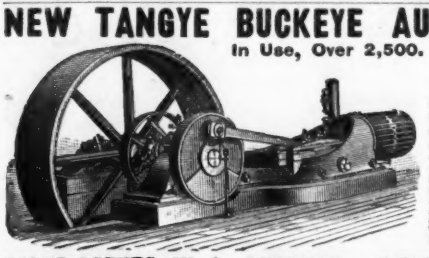
These Hack Saws will cut Iron and Steel beyond all expectation.
Iron working mechanics everywhere must and will use them. They do the work of files at one-tenth the cost, and in one-tenth the time. One Patent Nickel-plated Steel frame, and one dozen 8 inch Blades, sent by mail, prepaid, on receipt of $1.50. Hardware dealers will furnish them at at the same price. All saws marked with a star, and bearing our name are fully warranted.
MILLERS FALLS CO.,
93 Reade Street, New York

BOYNTON & PLUMMER,
WORCESTER, MASS.
Manufacturers of
Shaping Machines, Drilling Machines, Bolt Cutting Machines.
Send for Catalogue.

Bolt and Nut Machinery.
12 Sizes of National Bolt Cutters.
6 Sizes and Styles of Rapid Bolt Cutters.
5 Sizes and Styles of Bolt Pointers.
15 Sizes and Styles of Bolt Headers.
12 Sizes and Styles of Nut Machines.
14 Sizes and Styles of Tappers.
3 Sizes and Styles of Washer Machines.
3 Sizes and Styles of Spike Machines.
2 Sizes of Car Link Machines.
3 Sizes of Car Pin Machines.
7 Sizes and Styles of Wire Nail Machines.
5 Sizes and Styles of Bulldozers.
Also large variety of Tools in this line, making complete outfits for Bolt Shops. Catalogue sent on application. Apply to
THE NATIONAL MACHINERY CO.,
TIFFIN, OHIO.

NEW TANGYE BUCKEYE AUTOMATIC CUT-OFF ENGINES

In Use, Over 2,500. 25 to 1,000 H. P.



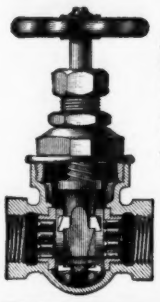
These engines are the combined result of long experience with automatic cut-off regulation, and most careful revision of all details. They are designed and constructed for heavy and continuous duty at medium or high rotative speeds. Highest attainable Economy in Steam Consumption and superior regulation guaranteed. Self-contained Automatic Cut-off Engines 12 to 100 H. P. for driving Dynamo Machines *a specialty*. Illustrated Circulars, with various data as to practical Steam Engine Construction and performance, free by mail. **Address, BUCKEYE ENGINE CO., Salem, Ohio.**

SALES AGENTS: **W. L. SIMPSON,** 10 TELEPHONE BUILDING, 18 CORTLANDT STREET, N. Y. / N. W. ROBINSON, 154 Washington St., Chicago, Ill. / ROBINSON & CARY COMPANY, St. Paul, Minn.

KENSINGTON ENGINE WORKS, LIMITED, PHILADELPHIA.

Sole Licensees and Manufacturers for New Jersey (South of Trenton), Eastern Pennsylvania, Delaware, Maryland, and Virginia.

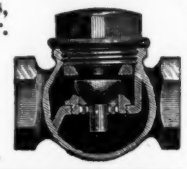
BLESSING'S RENEWABLE-SEAT GLOBE, STRAIGHTWAY and CHECK VALVES.



The Renewable-Seats and Disks are cast from the best Phosphor Bronze Metal, which has lasting qualities, double that of the best Steam Metal commonly used in first-class valves. The seats are simply screwed to place by the use of a special wrench furnished with each valve.

These valves are equally applicable to steam, water, or other fluid pressure.

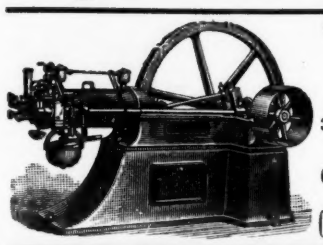
We also manufacture **Blessing's Albany Steam Traps, Water Circulator and Purifier; and Pump Governor.**



SEND FOR CIRCULAR.

ALBANY STEAM TRAP CO.,
ALBANY, N. Y.

"OTTO" GAS ENGINE WORKS



SCHLEICHER, SCHUMM & CO.,

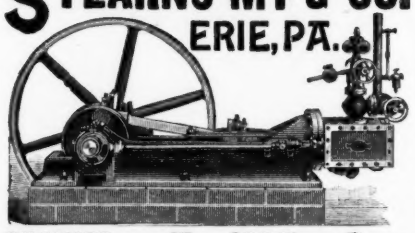
33d and Walnut Sts., PHILADELPHIA. Branch Office, 151 Monroe St CHICAGO.

OVER 25,000 ENGINES IN USE

GUARANTEED To consume 25 to 75 Per Cent. Less Gas than ANY Other Gas Engine doing the same work

STEARNS M'F'G CO.

ERIE, PA.



ENGINES from 15 to 400 Horse Power

Boilers of Steel and Iron supplied to the trade or the user. Send for Catalogue.

SAW MILLS and GENERAL MACHINERY

NEW YORK STORE, 46 Cortlandt St.

SAVE YOUR MONEY BY USING RIDER'S "Victor" Lathe and Planer Tool.

Cutters made direct from bar of Round Steel. *No fitting* required. Send Square or for prices.

FRANK L. B. RIDER, South Newmarket, N. H.

BRAINARD GEAR CUTTING MACHINES.

18 In., 24 In., 36 In., 48 In.

HILL, CLARKE & CO.,

General Selling Agents,

156 OLIVER ST., BOSTON, MASS.

MACHINE TOOLS

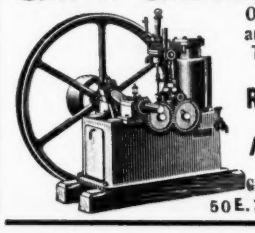
ENGINE LATHES,
BRASS LATHES,
BORING AND TURNING MILLS,
SCREW MACHINES,

on hand and in process of construction.

BRIDGEPORT MACHINE TOOL WORKS,

E. P. BULLARD, PROPRIETOR. BRIDGEPORT, CONN.

VAN DUZEN GAS & GASOLINE ENGINE



OPERATED with COAL and OTHER MANUFACTURED GASES AND GASOLINE.

RELIABLE AND ECONOMICAL.

Fully Warranted

VAN DUZEN Gas & Gasoline Engine Co. 50 E. 2d St., Cincinnati, O.

ROSE POLYTECHNIC INSTITUTE,

TERRE HAUTE, IND.—A SCHOOL OF ENGINEERING.

Well endowed, well equipped departments of Mechanical and Civil Engineering, Electricity, Chemistry, Drawing. Extensive Shops & Laboratories. Expenses low. For catalogue address C. A. Waldo, Lib'n.

MACHINE TOOLS

For Immediate Delivery.

One Driving Wheel Lathe 70″ swing; second-hand.
One Fifield Engine Lathe 30″ by 16′; new.
One Lathe and Morse Lathe 32″ by 17′; new.
One Lathe and Morse Lathe 36″ by 15′; new.
One Gray Planer 30″ x 30″ x 8′; new.
One Pease Planer 34″ x 32″ x 8′; new.
One Pease Planer 36″ x 36″ 8′; special; new.
One Powell Planer 36″ x 36″ x 12′ with 2 heads; new.
One Pond Planer 38″ x 38″ x 10′ with 2 heads; new.
One Powell Planer 48″ x 48″ x 14′ with 2 heads; new.
One Bement Axle Lathe; second-hand.
One Bement Slotter 12″ stroke; second-hand.

Send for complete List of New and Second-hand Tools.

HILL, CLARKE & CO.,
156 Oliver St., Boston, Mass.

MACHINERY ON HAND

Engine Lathe,	14 in. x 6 ft.	Fitchburg,	new
" "	14 in. x 6 ft.	Prentice,	"
" "	16 in. x 8 ft.	Fitchburg	fair order
" "	16 in. x 6–8 ft.	Prentice,	new
" "	16 in. x 8 ft	McMahon,	"
" "	18 in. x 8 ft.	Prentice,	"
" "	18 in. x 8 ft.	New Haven,	fair
" "	20 in. x 10 ft., with Taper, Compound Rest and Turret, Bridgeport,		good as new
" "	20 in. x 10-12 ft.	McMahon	new
" "	20 in. x 10	Wright,	"
" "	20 in. x 10 ft.	Fifield,	"
" "	20 in. x 8 ft.	Wood light,	good order
" "	21 in. x 10 ft.	Fitchburg,	good order
" "	25 in. x 10 ft.	New Haven,	fair order
" "	28 in. x 14 ft.	Fitchburg,	good order
" "	28 in. x 16 ft	Fay & Scott,	new
" "	32 in. x 16 ft.	" "	"
" "	38 in. x 18 ft.	Leonard,	good order
Pulley Lathes,	39 in., 2 heads,	Niles.	A-1 order
" "	26-36-50 in.	Stevens.	good order
Fox Lathes, several sizes,			"
Turret Lathes, 15-20-40 in.			new
Cabinet Turret Lathe, No. 2		Am Tool Co.,	good order
Planers, 10 in. x 10 in. x 24 in.		Hendey,	" "
"	22 in. x 22 in. x 5 ft.	Wheeler,	new
"	24 in. x 24 in. x 6 ft.	Lathe & Morse.	"
"	24 in. x 24 in. x 6 ft.	Fitchburg,	"
"	26 in. x 24 in. x 8 ft.	Pond,	good order
"	24 in. x 24 in. x 7 ft.	New Haven,	fair order
Shapers,	15 in. Stroke, Crank Motion,		new pattern
"	14 in. " Trav. head,	Fitchburg,	new
"	16 in. stroke, Eberhardt's Pat.,		"
"	17 in. "	Wright,	"
"	24 in. "	Hendey,	good order
Drills,	20 in. Comb Wheel Lever,	Prentice,	new
"	21 in. Back geared,	"	"
"	24 in. " " Self-feed,	F. S.	"
"	25 in. " " "	Blaisdell,	"
"	28 in. " " "	Currier & Snyder,	"
"	28 in. " " "	Prentice,	"
Brown & Sharpe, No. 1 Universal Miller,			good as new
Garvin No. 2 Universal Miller,			new

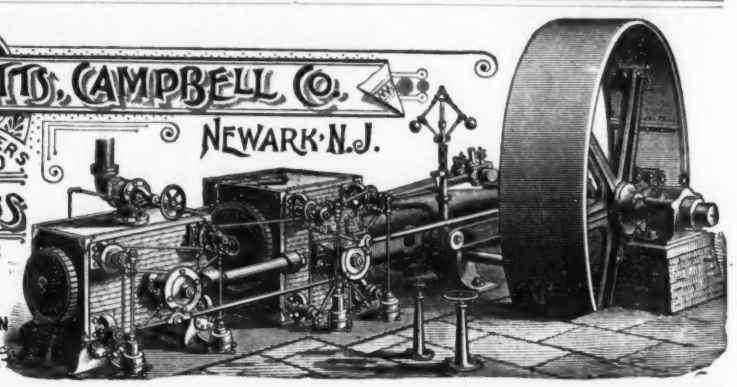
A Large Assortment of other Tools, New and Second Hand. Send for Complete List.

68 Cortlandt St., NEW YORK. **J. J. McCABE,** Successor to **E. P. BULLARD'S** New York Machinery Warerooms.

THE WATTS, CAMPBELL CO.

MANUFACTURERS OF IMPROVED CORLISS STEAM ENGINES IN FULL VARIETY.

NEWARK, N. J.



CONTRACTS TAKEN FOR COMPLETE POWER PLANTS

Eclipse Corliss Engine.

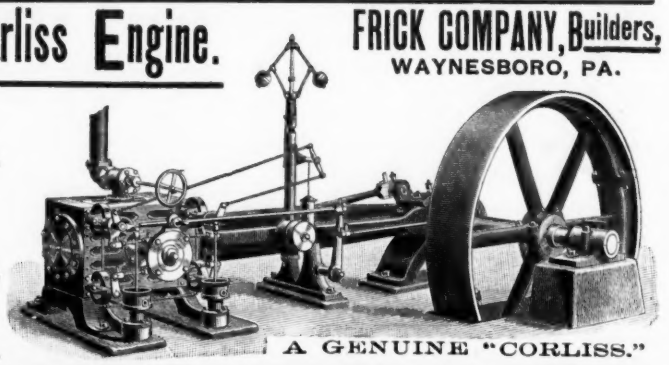
FRICK COMPANY, Builders, WAYNESBORO, PA.

NON-CONDENSING, CONDENSING COMPOUND. 40 TO 1,000 H.P.

Send for Circulars.

ICE-MAKING AND REFRIGERATING MACHINERY.

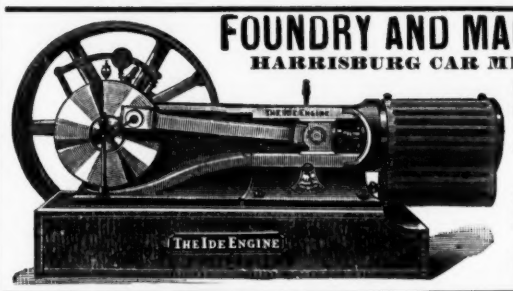
Send for Special Circular.



A GENUINE "CORLISS."

FOUNDRY AND MACHINE DEPARTMENT.

HARRISBURG CAR MFG. CO., HARRISBURG, PA.

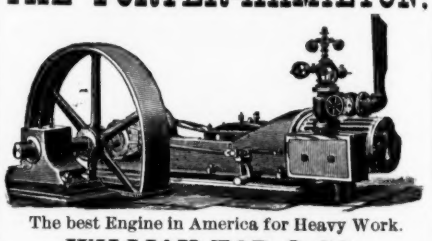


Highest Award SILVER MEDAL and DIPLOMA AT FRANKLIN INSTITUTE NOVELTY EXHIBITION, PHILADELPHIA.

We are operating the finest and most successful Electric Light Stations in the world. A change of speed not exceeding one per cent. guaranteed, running light and loaded. Send for catalogue.

New York Office, Fleming & Kimball, 17 Dey St. New England Office, John Post, Jr. & Co., 70 Kilby St., Boston. Baltimore Office, Thomas K. Carey & Bro., 35 Light St., Baltimore.

THE PORTER-HAMILTON.



The best Engine in America for Heavy Work.

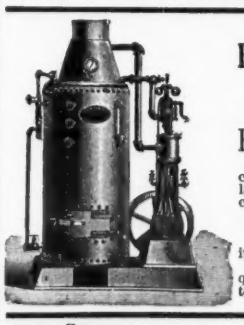
WILLIAM TOD & CO.,
Youngstown, Ohio.

CHANDLER & TAYLOR CO'S SELF-CONTAINED STEAM ENGINES

Are tested under full load before shipment.

12 TO 80 H. P. IN STOCK FOR QUICK DELIVERY.

For Circulars address CHANDLER & TAYLOR CO., INDIANAPOLIS, IND



LANE'S Foundry & Machine WORKS,

HUNTINGDON, PA.

Fine Upright Engines.

The following sizes are carried in stock, made in large quantities, with special tools, at special prices:

3, 4, 5, 6, 7 & 9 H. P.

If you want one Engine, it will pay you to write us. If you handle large quantities, it will pay you to write us.

—Novelty Patent Hand Drill.—

A new, ingenious and handy tool for drilling small holes, running at any speed desired. Operator can handle the work with one hand, and the drill with the other.

TINIUS OLSEN & CO.
Mfrs. Testing & Hydraulic Mach'y,
Twelfth and Buttonwood Streets,
PHILADELPHIA, PA.

FOR SALE. CORLISS ENGINES.

The Fishkill Landing Machine Co., located at **Fishkill, on the Hudson, N. Y.,** offer to manufacturers and others desiring a well-built, economical and durable engine, their improved **CORLISS ENGINES.** They are endorsed by many reputable engineers and persons using them. Address as above.

Corliss Engines

Of the highest type, in all sizes, are made by

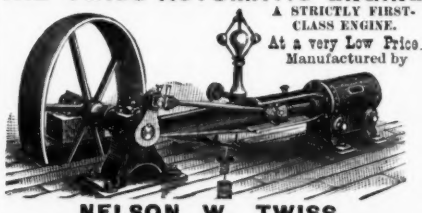
The Lane & Bodley Co.

CINCINNATI, O.

The merits of their engines are described in an illustrated pamphlet, which will be sent to any one interested.

THE TWISS AUTOMATIC ENGINE

A STRICTLY FIRST-CLASS ENGINE. At a very Low Price. Manufactured by



NELSON W. TWISS,
25 Whitney Ave., New Haven, Conn.
Send for Price before Purchasing Elsewhere.
ALSO VERTICAL AND YACHT ENGINES.

C. H. DE LAMATER & CO.

have closed their extensive manufactory at the Foot of West 13th Street, New York, and have sold the Hot Air Pumping Engine and Steam Pump business to the De Lamater Iron Works (incorporated in 1889), and the Propeller Wheel business to the Samuel L. Moore & Sons Co, of Elizabethport, New Jersey.

In order to close out the remainder of the stock, offer for sale

A Very Desirable Lot of Machinery,

such as lathes from 15″ to 88″ swing, planing machines 48″x45″x10′, 53″x50″x12′, 17″x14″x24′, 72″x69″x24′, and various other sizes; drilling machines, slotting machines, shaping machines, boring machines, bolt-cutting machines, cutting-off machines, nut tappers, milling machines, gear cutters, emery tool grinders, portable drills, screw-cutting machines, vises, lathe and planer tools, and a variety of small tools; also traveling and jib cranes.

Punching and shearing machines, for boiler makers, with a general outfit of small tools. Blacksmiths' tools, such as anvils, sledges, tongs, etc. Pattern lathes, benches, saws, screws, nails and a general supply of small tools. Foundry cranes, cupolas and small tools. Blocks, ropes, bolts, nuts, washers, packings, pipe and fittings, iron and brass valves. Boiler iron, steel plate and boiler rivets. Bar iron and steel, also steam hammers, and two 8″x16″ and one 10″x20″ Rider cut-off engines.

BALL AUTOMATIC CUT-OFF ENGINES,

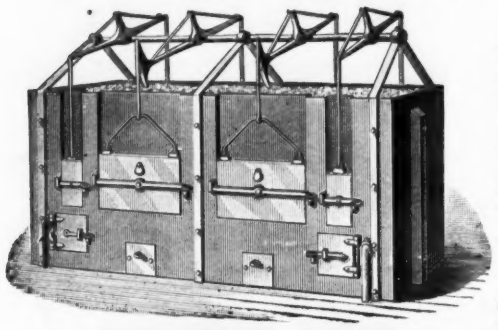
ERIE, PA.

The characteristics of these Engines are Beauty of Design, Superior Finish, Limited Feet in Space required, Economy of Fuel, Perfection of Regulation.

CHARLES R. VINCENT & CO.,
NEW YORK SELLING OFFICE, 15 CORTLANDT STREET.

BROWN & SHARPE MFG. CO.,

PROVIDENCE, R. I., U. S. A.



CASE-HARDENING FURNACE.

This Furnace is so arranged that without a loss of heat the interior of the oven can be readily seen. The temperature of the oven can be easily varied, or a uniform heat can be maintained for any length of time.

In 24 hours 150 lbs. of Lehigh Egg Coal is used.

We frequently harden by day and utilize the heat by annealing at night.

S. A. SMITH,

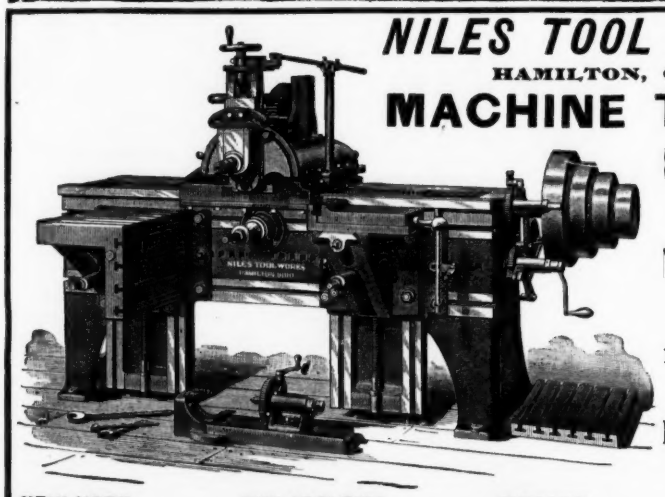
Western Representative,

23 SO. CANAL STREET, - - CHICAGO, ILL.

NILES TOOL WORKS,

HAMILTON, OHIO.

MACHINE TOOLS.



SHAPING MACHINES.

TRAVELING HEAD.

16, 18 and 24 inch Stroke.

Extra heavy and powerful.

NEW YORK, 98 Liberty St. | PHILADELPHIA, 705 Arch St. | CHICAGO, Phenix Building. | PITTSBURGH, Lewis Block.

GRANES

THE YALE & TOWNE MFG CO.
STAMFORD CONN
NEW YORK CHICAGO PHILA BOSTON

The Original Unvulcanized Packing

CALLED THE STANDARD—As it is the Packing by which all others are compared.

Accept no packing as JENKINS PACKING unless stamped with our "Trade Mark."

JENKINS BROS. 71 JOHN STREET, N. Y. / 105 MILK STREET, BOSTON. / 21 NORTH FIFTH ST., PHILA. / 54 DEARBORN STREET, CHICAGO.

FOR IMMEDIATE DELIVERY.

2 BACK GEARED MILLING MACHINES.
3 18 x 6 CABINET TURRET LATHES.
2 15 in. CRANK SHAPERS.
1 20 in. GEARED SHAPER.
1 24 x 24 x 6 IRON PLANER.
4 12 in. HAND LATHES.
3 12 & 15 in. TURRET BORING LATHES.
☞ ALL MACHINES OF OUR LATEST DESIGNS.

THE LODGE & DAVIS MACHINE TOOL CO.,

WORKS: CINCINNATI, O.

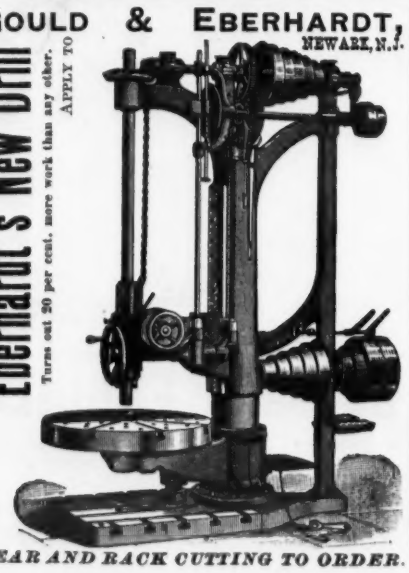
EASTERN HOUSE, 64 CORTLANDT ST., NEW YORK. | WESTERN HOUSE, 68 & 70 S. CANAL ST., CHICAGO.

☞ *SEE ADVERTISEMENT PAGE 16.*

GOULD & EBERHARDT, NEWARK, N.J.

Eberhardt's New Drill

Turns out 20 per cent. more work than any other. APPLY TO



GEAR AND RACK CUTTING TO ORDER.

NEW ILLUSTRATED CATALOGUE

NOW READY.

CONTAINS A GREAT VARIETY OF NEW MACHINES, and all the LATEST IMPROVEMENTS ON OUR REGULAR MANUFACTURES.

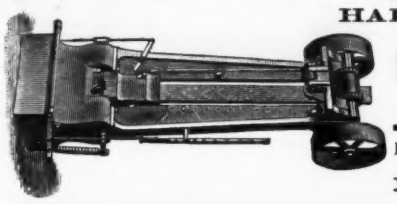
MILLING MACHINES,
SCREW MACHINES,
ETC.

THE GARVIN MACHINE CO.

LAIGHT & CANAL STREETS,
NEW YORK.

THE PRATT & WHITNEY CO.,

HARTFORD, CONN.



MANUFACTURE

DROP HAMMERS,

PUNCHING AND TRIMMING PRESSES,

—POWER SHEARS.—

Die-Sinking Machines, Hand Bolt Heading, Power Screw and Bolt Blank Heading Machines.

RETRACTILE JIB CRANES,

Roll Grooving Machines for Flour Mill Use.

PRICE LIST AND DISCOUNT SHEET SENT UPON APPLICATION.

WESTERN BRANCH, 100 West Washington Street, Chicago, Ills.

THE BILLINGS & SPENCER CO.

HARTFORD, CONN. U.S.A.

MANUFACTURERS OF BILLINGS' DROP FORGED LATHE DOGS FORGED FROM BEST STEEL FOR THE PURPOSE

IN 12 SIZES 3/8 UP TO AND INCLUDING 4 IN ALSO CLAMP AND DIE DOGS

DROP FORGINGS OF COPPER, IRON AND STEEL OF ALL DESCRIPTIONS

WARNER & SWASEY,

CLEVELAND, OHIO,

MACHINE TOOLS

For Iron and Brass Work.

SMALL TOOLS & FIXTURES.

Gear Cutting in all its Branches.

ILLUSTRATED CATALOGUE ON APPLICATION.

GEO. W. FIFIELD, MANUFACTURER OF

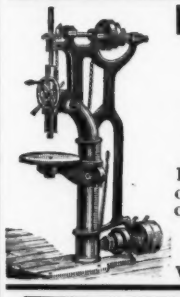
ENGINE LATHES

FROM 16 to 48 IN. SWING.

Cuts, Photographs and Prices furnished on application.

Lowell, Mass., U. S. A.

Every machine or manufacturing concern should send for the list of 600 sizes of cut iron spur and bevel gear wheels and racks lately issued by the Lexington Gear Works, of Lexington, Mass.
(GRANT.)



Key-Seating Machines and 20 in. Drills

A SPECIALTY.

SEND FOR LIST OF

New and Second-Hand

Lathes, Planers, Drills, or anything in Machinists' Tools or Supplies.

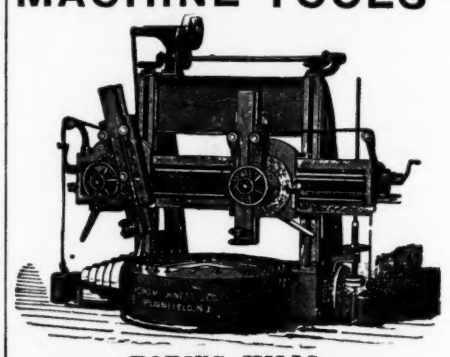
W. P. DAVIS,
Rochester, N. Y.
Works at North Bloomfield.

THE POND MACHINE TOOL CO.,

Formerly of Worcester, Mass.

MANUFACTURERS OF

MACHINE TOOLS

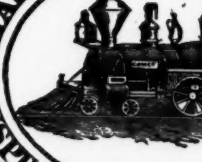


BORING MILLS.

Radial Drills, Planers, Lathes, Heavy and Powerful, from new patterns of the latest and best designs.

SALESROOM & OFFICE, 113 Liberty St., N. Y. City.
NEW SHOPS, PLAINFIELD, N. J.

HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

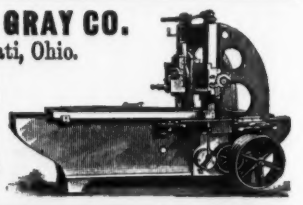


J. M. ALLEN, PRESIDENT.
WM. B. FRANKLIN, VICE-PRESIDENT.
F. B. ALLEN, SECOND VICE-PRESIDENT.
J. B. PIERCE, SECRETARY & TREASURER.

THE G. A. GRAY CO.

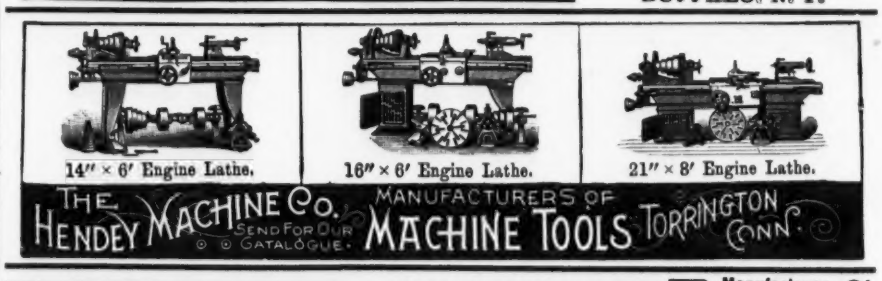
Cincinnati, Ohio.

PLANERS AND LATHES A SPECIALTY.



STEEL CASTINGS.

PRATT & LETCHWORTH,
PROPRIETORS
BUFFALO STEEL FOUNDRY,
BUFFALO, N. Y.



14" × 6' Engine Lathe. | 16" × 6' Engine Lathe. | 21" × 8' Engine Lathe.

THE HENDEY MACHINE CO. SEND FOR OUR CATALOGUE. MANUFACTURERS OF MACHINE TOOLS TORRINGTON CONN.

Manufacturer —of— TAPS & DIES